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DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

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EVERYTHING PNEUMATIC

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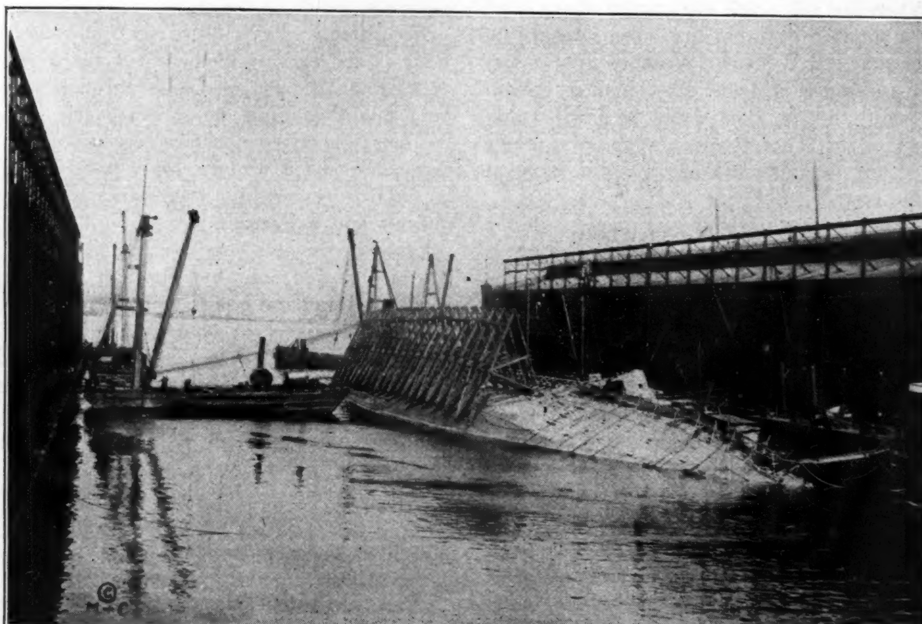


READY TO ROLL THE ST. PAUL

THE WONDERFUL SALVAGE FEAT OF RAISING THE ST. PAUL

The refloating of the wrecked steamer St. Paul—wrecked not on a rocky coast or on the open sea, but in the quiet of New York harbor— is to be reckoned as one of the greatest feats of salvage engineering. The entire story of it was graphically narrated by Robert G. Skerrett in *The Sun*, New York, on Oct. 13, and from that account we abstract freely.

The St. Paul was to have done her share in the transportation of troops and supplies across the Atlantic, and for this purpose she had been refitted in a local shipyard, was towed to her pier to take on her load and while being warped to her berth she heeled heavily to port, water poured in through various openings and she filled and settled to the bottom with her starboard side uppermost and only fifteen feet above the surface at low tide.

In rolling over the liner smashed her smokestacks, crumpled up her masts and dumped overboard into the narrow space between the pier and the ship, a confused mass of loose

material of all descriptions, and at the same time she sank fourteen feet into the mud. The slip also was so narrow between the piers that this was an additional and most serious complication.

A DOUBLE PROBLEM.

The wreck presented a twofold problem to the engineers; first, to roll her upright, and second, to pump her out. But first it was necessary to clear away the damaged masts and smokestacks, remove top weights amounting to hundreds of tons, hoist off her guns and get rid of the litter that lay submerged beside the ship just where the divers would have to operate.

When the ship sank she carried down with her a number of rapid fire rifles intended to repel attacking U-boats. Weapons of that sort were too much in demand to let them remain idle until the St. Paul could be made ready again for sea. Therefore one of the first things called for in lightening her was the removal of the guns.

Those on the starboard or upper side of the wreck were above the surface of the water and could be removed easily, but the lower guns on the port side presented a very different task. They were buried deep in the mud, ten or more feet, and were quite beyond the reach of the underwater workers.

COMPRESSED AIR GETS TO WORK.

In order that the men might reach the guns the silt overlying the rifles had to be excavated For this purpose compressed air led through hose was employed to blow away the mud. When the pieces were thus uncovered slings were attached to them so that the weapons could be hoisted to the surface at the right moment, but with this done the most ticklish part of the salvage of the rapid firers yet remain unaccomplished.

Before the guns could be raised it was necessary to cast them loose from the deck, to which they were secured by massive bolts and nuts. The divers achieved this despite the dim vision possible in the muddy water and the uncertain footing.

Again, the crumpled masts and smokestacks had to be got out of the way. Not only were these considerable weights, with tangled stays and rigging, but in the case of the funnels the masses of steel were of great bulk and awkward to deal with. By means of skilfully placed sticks of dynamite the masts were severed, and the smokestacks were similarly blasted free about six feet above the uppermost deck.

The following information detailing the successive stages of the work is furnished us by Mr. Ralph E. Chapman, Salvage Engineer of the Merritt & Chapman Wrecking Company.

When the St. Paul sank and settled into the silt at the bottom of the slip the mud entered the lower part of the liner through numerous openings and also accumulated in the alleyways along decks 1 and 2 on the port side. This accumulation went on from day to day, and it was important that the hampering process be halted or checked as far as possible, especially inside of the craft.

Accordingly, divers were sent into the St. Paul at the earliest moment for the purpose of closing all open portholes through which mud might continue to ooze inboard. Only the most expert of our men were chosen for that work, and it was necessary to be particular in that respect, for their tasks were both difficult and dangerous.

Lying as the ship was over on her side the silt had flowed into her through scores of open ports and the points to be reached were buried in blankets of mud ranging from six to eight feet thick. The divers had to search out these openings by using air and water jets, and to get to their objectives it was needful that they follow devious routes and go along passages filled with many pitfalls. The submerged interior of the liner was inky black, and the underwater workers depended entirely upon their acute sense of touch.

FITTING A COVER TO AN OPEN PORT.

While exploring for openings the divers found that a large hole existed which it was imperative should be closed. This inlet for the mud was in an awkward place and a good many feet under water. There was no way to seal it except from within the ship, because the place could not be reached from the outside.

The job involved making a pattern of the opening and its existing bolt holes, fashioning a patch plate and then carrying the plate down and fitting it in place. Again the divers who made the pattern and afterward closed the port worked without light, and notwithstanding there were nearly thirty bolts to be placed and as many nuts to be tightened the installing was effected in less than two days. The patch

when subsequently inspected was found to be absolutely watertight.

Not only were the divers required to close all openings that were likely to interfere with the pumping out of the liner in refloating her, but it was equally necessary to create openings to facilitate the draining of the water to points where it could be reached by the pump intakes. In a number of cases bulkheads and other steel barriers were broken through by means of dynamite to facilitate this movement of the contained water, and the sticks of explosive were tied in place by our underwater workers, the charges being afterward set off by electricity.

UNDER WATER CUTTING TORCH.

The objection to this procedure lies in the rather extensive structural damage invited locally and the resulting cost of repairs. To offset this J. E. Kirk, machinist foreman and a capable diver, and Mr. Chapman experimented for weeks with a cutting torch of their own devising, and eventually they succeeded in perfecting it so that the oxy-acetylene flame would do its work under all conditions. They were able to cut holes with precision and despatch through any steel wall, and openings were thus made up to fourteen inches in diameter, the actual cutting time being a matter of a very few minutes. The deepest opening made in this way within the St. Paul was more than fifty feet below the surface of the water.

The work inside the liner involved the sealing of several hundred openings of one sort or another. It was decided at the start to isolate the forward and after ends of the craft from her middle body and to pump out the bow and stern regions. To this end it was necessary to close certain of the hatches and to provide temporary barriers.

MAKING WATER-TIGHT COMPARTMENTS.

For this work we used massive cement patches and walls, which we installed under water. These proved entirely satisfactory and enabled us to exert buoyant impulses just where we wanted them during our initial efforts to turn the vessel upright. The water was controlled by more than twenty pumps, three of them being twelve inch centrifugal wrecking pumps.

Because of the confined area in which the St. Paul lay it was not deemed practicable to approach her as we might otherwise have done had she been sunk in open waters. The ship sank in a way to block to a large extent the slip between Piers 60 and 61. The slip is 240 feet wide, while the St. Paul, lying on her side took up quite eighty feet of this, and at one point there was but fifty feet between her upper structure and the nearby dock.

The liner is 535 feet long and has a beam of 63 feet, and as a mass to be moved she represented more than 13,000 tons, fully double the weight of any other craft ever refloated from a similar posture. We realized that special facilities would have to be employed to roll the craft over on an even keel from her heel of 73 degrees.

TO ROLL HER OVER.

The problem was to turn her upright without shifting her laterally the while, and the rolling pull called for leverage exerted differently at different stages of the work. To facilitate the righting operation there were constructed and placed on the upturned starboard side of the St. Paul twenty-one tripods, technically termed A frames, fashioned of steel and timbers, and steel hawsers led from these to twenty-one cement anchoring blocks, each of ten tons, sunk in a trench dredged for them in the slip to the south and between Piers 60 and 59. The pull on these tackles was exerted by twenty-one hoisting engines firmly secured to the deck or floor of Pier 60.

LIFTING PONTOONS.

All during the month of May dredging operations continued on both sides of the wreck for the double purpose of clearing the way for the divers and on the south side of providing deeper water into which the liner might be shifted during the concluding work of righting and refloating her. The divers had to get close to the ship to attach the chains and steel hawsers which, with the aid of pontoons on the north side, were to help roll the craft upright. The other aid to the movement was the series of A frames just mentioned.

After weeks of preparation the rolling operations were started on July 22 and continued until July 28, the ship by that time being brought up to a point where her heel was reduced to 27 degrees, which was as far as the pontoons could be utilized effectively. This ended the first stage of the moving of the craft. The pontoons, which had co-operated with the A frames, were now taken off the job and the work was then started of complet-

ing the closing up of the entire ship so that she could be pumped out as a whole.

COFFERDAMS.

Closing up called for the building of a cofferdam more than 360 feet long on the port side and something over 290 feet on the starboard side. By means of these cofferdams the liner was finally made watertight to a level just above the river's surface at high tide and she was, in effect, converted into a gigantic flask which could be drained deliberately by the array of pumps assembled upon her decks.

The chains previously attached to the pontoons during the pulling on the A frames were next gripped forward and aft by two great wrecking craft, the derricks Monarch and Commander, which exercised a lifting and heeling force while the pumps were getting rid of the water within the St. Paul. In this way the salvors succeeded in bringing the vessel back within 16 degrees of vertical. This ended the second stage of the work.

The third stage of the undertaking consisted in pumping the entire ship while steadying her by four floating derricks, two on each side. This was done on September 11, and within five hours after starting the pumps the liner floated clear of the bottom fore and aft, assuming a position with a list of 4 degrees to port, which was due to the mass of wreckage that had gathered there when the vessel sank and turned over. This heel was overcome by the placing of compensating ballast on the starboard side.

Once fully afloat workmen were placed on the ship cleaning her up and installing certain apparatus for the liner's machinery. While as much mud as possible was removed during the various stages of rolling and raising the St. Paul, still when she was finally afloat it was found that there yet remained a thousand tons of the oily, smelly silt throughout the craft on her port side. This was got rid of and the St. Paul was turned over to representatives of the American Line on September 27.

Great credit is due Capt. I. M. Tooker, the wrecking master, whose shoulders bore the supervisory burden of the entire job. Undismayed by snapping hawsers and the occasional failure of other apparatus, he watched over the task like a general guiding a battle and mustered his corrective forces with winning skill.

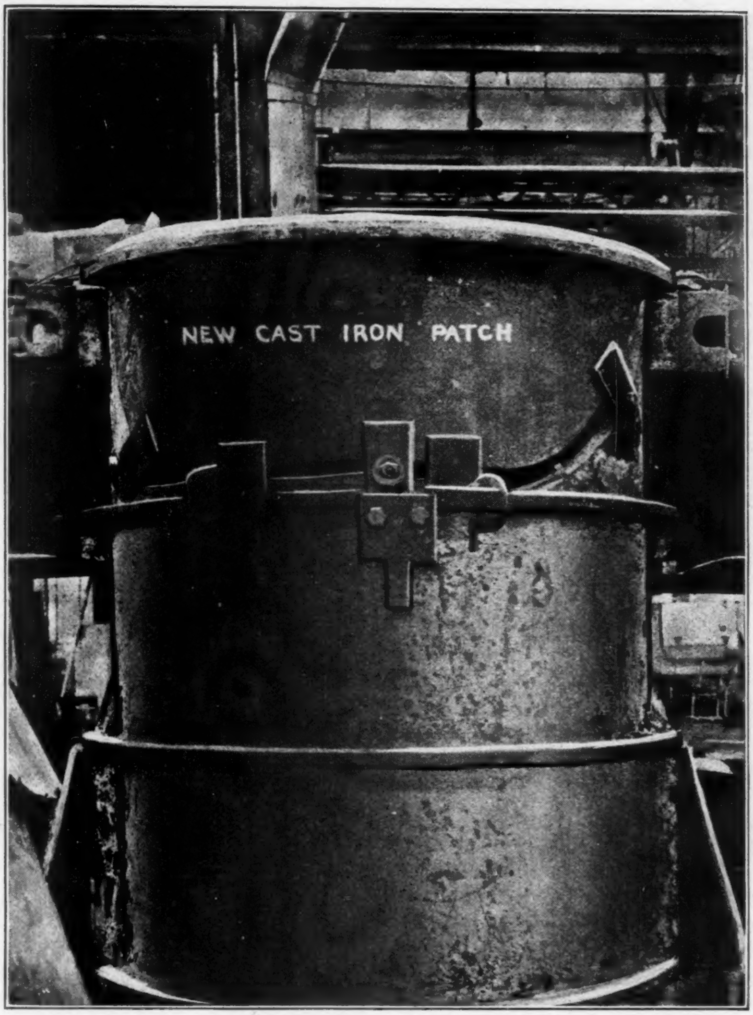
OXY-ACETYLENE PROCESSES IN THE WAR*

The war with its constant call to meet emergencies and new and unexpected situations has demonstrated the value of the oxy-acetylene process.

Ammunition requirements have given a great impetus to its use in the welding of depth bombs, aero bombs, grenades, sea mines and torpedoes; in cutting off bars for slugs and shells; in reclamation of defective shells, cutting billets for gun forgings, etc. The process is used to large extent on Liberty trucks and motors, and in the construction of aeroplanes and motors. It has been invaluable in reclamation work. The constant damage caused by wear and tear, accident or shell fire at the front makes it imperative to reduce wastage to the minimum copatible with speed of replacement or repair. A broken or injured part means idleness until a new part is supplied or the damage is repaired. If the repair can be effected economically and speedily it follows thaat the damaged part will not be wasted, that the call for new parts will be reduced, and that much valuable hauling space will be saved by not having to constantly bring in repair parts. It may often happen, however, that the damage is not confined to one part and involves thorough overhauling or replacement on a large scale, making the object in question, whether it be a truck, locomotive, aeroplane, or what not, useless for a certain time and imposing an additional burden on transportation; in a number of cases the damage done is so great that replacement is impracticable. Oxy-acetylene welding meets the problem in that broken or otherwise injured parts may be speedily and efficiently reclaimed and that badly damaged objects needing general overhauling can be put back into activity within a short time.

The machinery of the interned German vessels was so badly damaged that it was looked upon as a difficult job to put them into commission, as many of the injured parts could not be made with the machine equipment we had in this country at the time. The only recourse was to restore the damaged parts and this was successfully accomplished by welding, using the electric arc and the oxy-

*From Bulletin No. 11, Federal Board for Vocational Education.



READY FOR THE WELD

acetylene flame. (See cut). In some cases the oxy-acetylene cutting blowpipe had been used to do the damage. The cuts were nicely filled in and camouflaged, but a clumsy error was committed in forgetting that what oxy-acetylene can destroy, oxy-acetylene can restore—and restore it did, for not one of the damages passed undiscovered. In towing one of these ships, the *Huron,* to the Brooklyn Navy Yard, it was found necessary to cut off 20 feet of mast in order to pass under the Brooklyn Bridge. The oxy-acetylene blowpipe came into play and the work was performed satisfactorily and in a short time.

Oxy-acetylene has, in some cases, been found more efficient by the armies for wrecking bridges and other structures than dynamite.

An acetylene blowpipe of special construction is used by submarines for cutting nets under water.

In action before Belgrade the turret of a gunboat was struck by a shell and partly demolished, imprisoning the men. After the action was over a hole was cut in the turret and the men liberated.

It is known that when possible the Germans have damaged by the oxy-acetylene flame guns about to be captured by the enemy.

OXY-ACETYLENE WELDING IN THE FRENCH ARMY

Oxy-acetylene welding is used extensively by the French Army for both manufacturing and repair work. Its use in manufacturing is practically the same as in the United States. In repair work it is used at posts situated out of range of shell fire, as it has been found that the men can not do efficient work when exposed to fire. It is also used at all base repair shops at Paris and other cities. Whenever possible, damaged parts are replaced by new ones, otherwise the work is moved to a repair camp in the rear. At the repair camp the work is usually carried on in a small hut about 12 feet square, although in some cases it is done in the main repair sheds. Acetylene is usually generated at the repair huts, and is used in cylinders only when necessity demands it. Portable generators are employed for large work which can not be handled niside the hut. Oxygen is obtained in cylinders holding from 6 to 7 cubic meters.

The use of the process by the French Army has two limitations: First, lack of capable welders; and, second, limited supply of oxygen cylinders.

With the first call to the colors the men experienced in welding were sent to the trenches, but later were recalled to industrial work, especially in the manufacture of bombs used in trench warfare, aeroplanes, etc. As a consequence very few men can be spared for repair work at the front, and there is a consequent loss, wastage, and burden on transportation which could otherwise be avoided.

Organization.—Each army has its own corps of engineers, autos, artillery, railroads, aeroplanes, and each one of these divisions looks after its own repair work. So far as oxy-acetylene is concerned they work independently of each other.

Apparatus.—The apparatus used in the Army is practically the same as that used in industrial work. The amount of apparatus needed depends on number of heavy guns, light guns, motor cars, miles of track, airplanes, bridges, amount of piping, activity of the Army, etc.

Field of Utility.—The oxy-acetylene process is used in the following branches: Aeroplanes (including lorries), artillery, automobiles (autos, trucks). engineers, railroad work.

Aeroplanes.—One welding set and two expert men are used for each 150 aeros. This is independent of welding apparatus used for motor lorries. The French do not repair cracked motor cylinders at the front, as they feel that so much depends upon the motor that they can not afford to run any chances.

Artillery.—One set of apparatus and two expert welders for each 100 guns of 105 mm. to 280 mm. cali. Somewhat less for smaller calibers. This will also take care of trench guns and mortars. The welding is mostly done on gun carriages, accessories, gun feet, etc., rather than on gun or barrels themselves. When badly damaged, the artillery is sent to the repair camp. New guns are daily sent forward, and the old or damaged parts are returned to the park, as the artillery camp is called. The park is equipped with lathes, forges, etc., so that extensive repairs can be made. When guns are too badly damaged, the undamaged parts are used in forming new ones. Two experienced men are used in this assembling work. Two experienced men are used for each welding set, as well as two or three helpers—inexperienced soldiers or even German prisoners being employed as helpers.

Automobile Service.—Autos are subject to damage by ordinary wear and tear, accidents, and shell fire. Autos breaking down en route are repaired, where possible, by replacement of old parts by new ones, broken parts being returned to parks or else thrown away. There are about 50 such parks in France taking care of 1,000 to 2,000 cars each. Outside repairs to cylinders are executed at parks, but inside repairs at Paris, where suitable boring tools are to be found. At one reserve park situated about 30 miles from the front they employed three sets of apparatus and four men and used 1½ bottles or 10 cubic meters of oxygen per diem. This park served 3,000 automobiles. One set of apparatus and two men are needed for each 400 to 500 autos, including trucks and passenger autos.

Engineers.—The departments of the engineers are: Department of bridges, electricity, searchlights, engineers' park for waterworks, etc. The last two departments mentioned do not employ oxy-acetylene welding.

Department of Bridges.—One set of apparatus and two welders are furnished to each army corps. Dissolved acetylene is used on account of its transportability. The process is used for cutting broken bridges and repairing pontoon boats, and, as the men have to

(*Concluded on page 8958*).

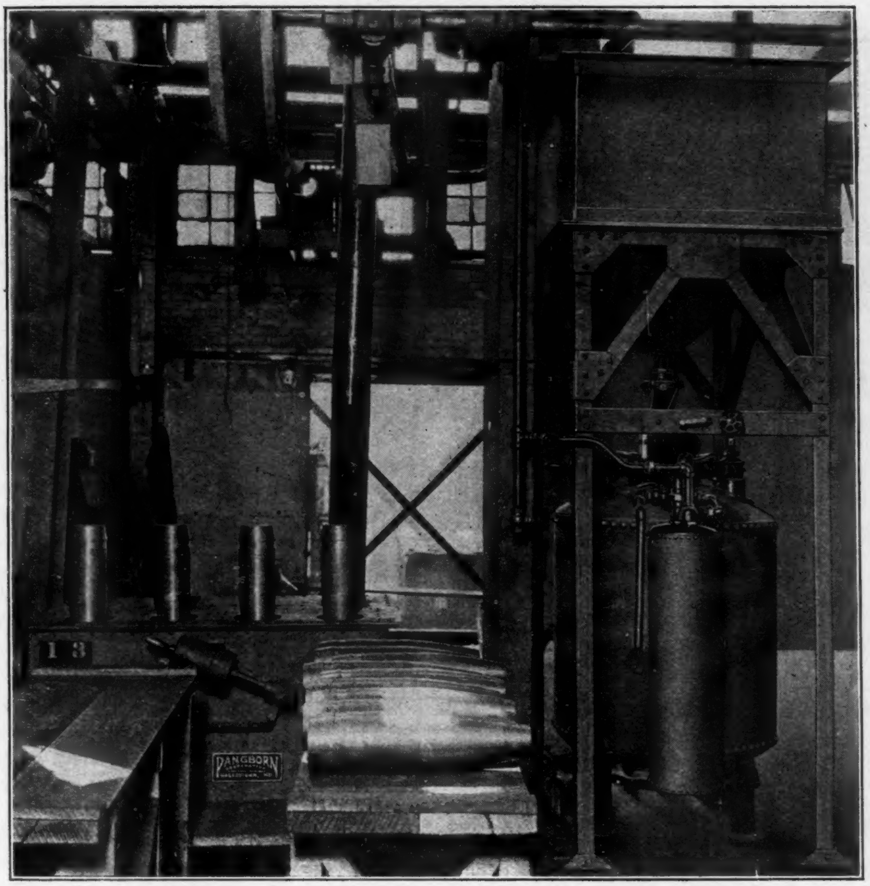


FIG. 1

AN AUTOMATIC SHELL CLEANSING SAND BLAST APPARATUS

In the processes of shell manufacture the perfect cleaning of the interiors is an operation of importance and the sand blast is most efficient for the purpose, while the numbers manufactured have made an imperative demand for apparatus specially adapted to the work. The arrangement here shown, built by the Pangborn Corporation, Hagerstown, Maryland, provides continuous operation for cleaning 155 min. (6.1 in.) shells with direct high pressure air. Fig. 1 is a front and Fig. 2 a rear view of the entire arrangement. Primarily it consists of a cabinet in which are mounted four rotating chucks or carriers driven at slow speed on dust protected ball bearings. The chucks are driven by belt from a main drive at the rear of the cabinet, see Fig. 3, the alternate chucks turning in opposite directions. All the rotating mechanism is contained in a separate dust tight compartment as shown.

A direct high pressure sand blast machine

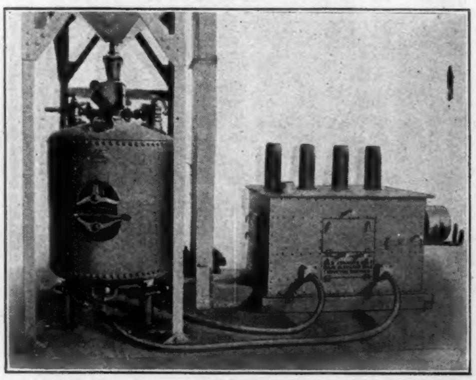


FIG. 2

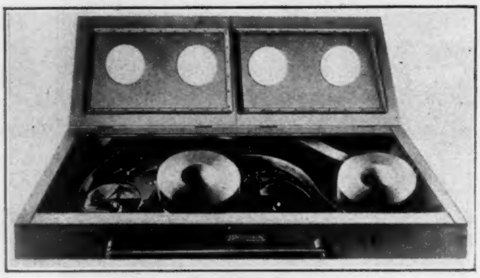


FIG. 3

with two lines of hose feeds two nozzles which are positioned to deliver the sand blast within the nose openings of alternate shells. The shells are placed in the rotating chucks with the openings downward, and as either two alternate shells are cleaned the nozzles are thrown over by a weighted hand lever on the front of the cabinet to the other two shells without stopping the blasting action, and then the cleaned shells are removed and other shells placed in the chucks for cleaning. Fig. 4 shows the suspending levers and the nozzles within the cabinet.

A hopper formed in the bottom of the cabinet receives the spent abrasive which is conveyed to an elevator and raised to a separator over the sand blast machine which by mechanically operated screens and strong exhaust at one operation removes both fine and coarse material which passes to a refuse bin, the clean, sharp abrasive for re-use being delivered to a storage bin for refilling the machine.

The machine may be used with either sand

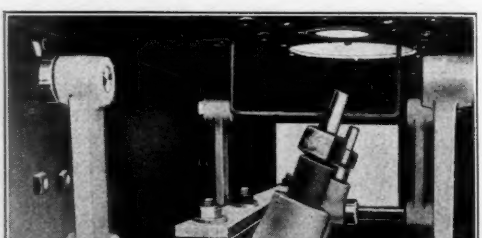


FIG. 4

or the metal abrasives, and the equipment as here shown in actual practice is cleaning 90 shells 155 mm. per hour. The cabinet is also made for shells of other sizes as required.

THE MARBLE CAVES OF OREGON

By F. A. Tuck

Amid the wilds of Southwestern Oregon, almost unknown to the world at large, is situated a series of underground chambers and passages remarkable for their size and for the beauty and unusual character of their decorations. Within the last few years they have been made a national monument and are now known as the Marble Caves of Oregon.

At the present time a visit to the caves is no small undertaking. From Grants Pass or Medford, a thirty-mile drive, takes one to the camp at the end of the wagon road. The rest of the trip must be made on foot or mule back up a steep trail ten miles in length. During the summer months the Forestry Service stations a forester at the caves as guide and caretaker. He takes a special interest in conducting all visitors through the caves and in pointing out to them the many interesting features of the trip.

The caves consist of three and a half miles of marble passages and grottoes, ranging from one to four or five stories in height. In places the connecting corridors are so low that one must crawl on all fours for a considerable distance. Elsewhere the chambers are so large that the opposite walls and ceiling are scarcely visible in the dim candle light. The largest cavern measures over 500 feet in length and its arched ceiling is 100 feet above the floor.

Throughout the entire cave the stalactitic formations are rich and wonderfully varied. In some chambers the ceiling is a mass of small stalactites, from the points of whcih hang starlike glittering pendants—drops of water. In one superb room the roof is covered with gigantic inverted white tulips; in another folds of massive draperies cover the walls supported by immense fluted columns. Here stalactites reach down from above and embrace their stalagmitic sisters, thus forming pillars of surpassing symmetry and beauty. There a miniature Niagara stands outlined in white marble, beyond which a magnificent Solomon's Temple is carved deep into the heart of the mountain.

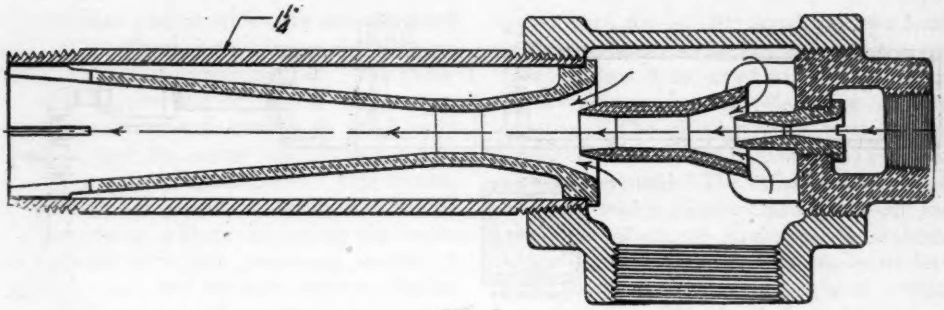


FIG. 1

AIR SYPHON BLOWERS FOR RIVET FURNACES

The use of high pressure air for rivet furnaces in a great majority of shipyards is not only overtaxing the capacity of the air compressor plants in many cases, but is resulting in a waste of power that does not seem to have been generally appreciated.

In a yard where 25% or 30% of the total air supply compressed to 100 lbs. is used to support combustion in rivet heaters at a pressure of less than ½ oz., the loss of power is readily apparent.

A large percentage of the high pressure air now used for this purpose can be saved by the application of a jet syphon to the air connection near the rivet furnace. The high pressure air passage through the nozzle of the syphon draws in a liberal quantity of free air which is mixed with the initial air, and delivered to the furnace with it.

The percentage of induced free air taken in under fixed conditions depends entirely on the more or less correct design of the syphon blower, and runs from 30% in some of the crude arrangements which have been improvised by some of the ship yards to 75% or 80% for the best standard makes of syphons, which have been carefully tested out by the Standard Practice Branch of the Emergency Fleet Corporation.

The higher efficiencies are obtained by multiple nozzle arrangements, in which a very small high pressure air jet (less than ⅛" in diameter for an ordinary rivet heater syphon) discharges through an injector tube drawing in a small quantity of free air. The first injector tube discharges into a second one forming a second syphonic action, etc., which is carried on through successive stages where high pressures are to be reduced to relatively low ones.

The accompanying cross sectional sketch, Fig. 1, shows a simplified design of a two-stage rivet furnace blower which is suggested in the interest of economy in construction, and Fig. 2 shows its application to a rivet furnace.

In this design a standard 1¼ in. screwed pattern cast iron tee is used for the body of the instrument. The self-contained cast brass nozzle arrangement is screwed into one end of the tee and provided with threaded connection for high pressure pipe, while the delivery tube connecting the body to the furnace is screwed into the other end. In order to give rugged construction and further economize in production, a short piece of standard pipe is used for the delivery tube and the correct syphonic proportions are obtained by the insertion of a non-corrosive lining. If the nozzles are properly proportioned, blowers of this design will give thoroughly good results.

Syphon blowers of the very highest efficiency can be obtained from regular manufacturers, and further information with reference

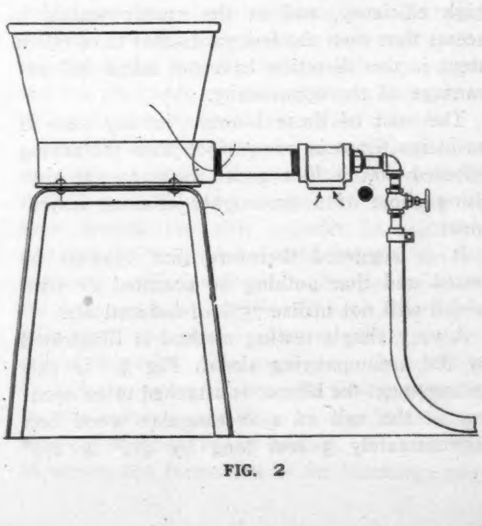


FIG. 2

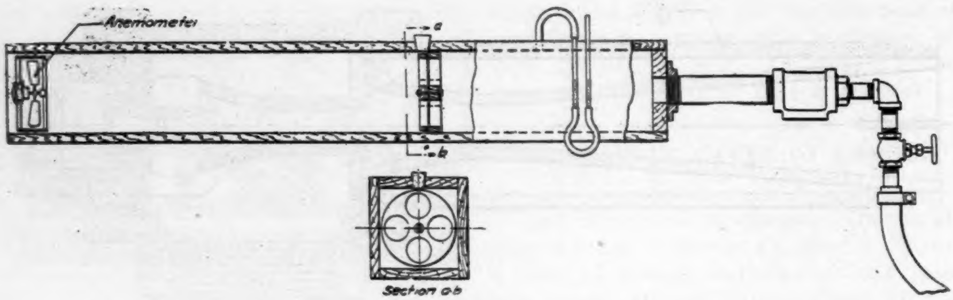


FIG. 3

to them will be furnished on request. It is quite likely that patterns and tools will be developed by some of these manufacturers for the production of the simplified instrumen illustrated herein, provided there should be sufficient demand for them, and in this case the tubes would no doubt be carefully developed for highest efficiency.

The average air used by a rivet furnace runs from 20 to 40 cu. ft. per minute. A properly designed syphon blower will easily reduce the high presure supply to 25% of the total, utilizing 75% of free air in the furnace.

Figuring the average furnace air supply at 20 cu. ft. per minute, the saving effected would be 1500 cu. ft. of high pressure air per minute or approximately 250 horse power for each 100 rivet furnaces in operation.

A few ship yards have made some progress in the application of the syphon blower principle to rivet heaters and some manufacturers are furnishing heaters with syphon attachments, but so far as these have been observed and tested out, they have not been designed for high efficiency, and as the matter stands it seems that even the few yards that have taken steps in this direction have not taken full advantage of the opportunity.

The cost of these blowers in any case is so insignificant in comparison with the saving effected that it is a great waste to use anything short of a thoroughly efficient instrument.

It is suggeted therefore that blowers be tested and that nothing be accepted or used which will not utilize 75% of induced air.

A very simple testing method is illustrated by the accompanying sketch Fig 3. In this arrangement the blower is attached to an opening in the end of a rectangular wood box approximately 3 feet long by 4½" x 4½" inside cross sectional measurements. A partition is located near the inlet and is fitted with a wooden disc loosely attached with wood screw at center. Four 1½" equidistant holes are bored through disc and partition, as shown in the sketch, for the diffusion and passage of the air, and a hole with stopper is provided through the top of the box immediately over the disc so that it can be rotated to gauge the size of the openings through the partition for the purpose of imposing a resistance or back pressure on the blower, equivalent to the resistance of the fuel bed in a rivet heater.

A bent glass tube partially filled with water is attached to the side of the box and connected with the first compartment to show the extent of this resistance, which should be adjusted to a ½" water head.

An anemometer is placed in the outer end of the box to register the flow of air which will be calculated in cu.ft. by dividing the anemometer. reading by 8.

In testing open the air valves on the blower until the anemometer reading reaches 280 with the resistance adjusted at ½" of water. This would represent 35 cu. ft. of air per minute. Next close the free or induced air inlet of the blower without changing the adjustment of the air supply valve and this will give the net direct or high pressure air reading, which compared with the previous total will give the efficiency of the device.—*Emergency Fleet News.*

THE SCHOOP METAL-SPRAY PROCESS IMPROVED

By increasing the "atomizing pressure" in the "pistol" of the Schoop apparatus, metal deposits of very fine grain and high density and strength have recently been obtained. The pis-

tol is a blow pipe in which the metallic bead, fused by the flame, is torn away and atomized by the current of compressed air. The ordinary working pressure of the air is 3.5 atmospheres, but the pistol operates on the injector principle, and the actual atomizing pressure was so far only 1.5 atmospheres. This atomizing pressure has recently been raised to 2.5 and 3 atmospheres without increasing the working pressure, with very promising results. A lead pipe 1 mm. wall thickness made by the improved process was filled with hydrogen at 5 atmospheric pressure while lying in water; no hydrogen escaped, while hydrogen bubbles forced their way through a lead pipe made by the old process. In another experiment plates of sheet-iron were covered with lead, one or two coatings at pressures of 1.5 or of 2.5 atmospheres. The one or two coatings of the old process did not prevent subsequent rusting of iron, but both the one coating and the two coatings of lead, deposited at the higher pressure kept the plates free of rust when they were placed in water.—*Engineering.*

LUBRICATION OF AIR COMPRESSORS

By W. H. Callan

The lubrication of the air compressor, steam cylinder, main bearings, crankpin, crosshead pin, crosshead guide, etc., does not differ from that of the ordinary steam engine, which is very well known and understood; hence the discussion in this article will be confined to air-cylinder lubrication only.

Years ago when we were young in the compressor business considerable trouble was experienced in procuring a suitable oil for lubricating the air cylinders of our compressors. After considering the matter for some time it was decided that an expert on the subject should be consulted. The matter was taken up with a well-known oil company whose representative called upon us, and after making careful examination of the conditions he reported that our trouble was entirely due to using an oil too light in body and too low in viscosity to withstand the high heat of the compression. He stated that the oil we were using was gasified, due to the high temperature of the air, and that it passed off in vapor, leaving the cylinder wall without lubrication, and recommended a suitable oil. The grade was 26 Baumé gravity with a flash point of 515 deg. F., fire test of 555 deg. F., and viscosity of 130 S. at 212 deg. F. After having used this oil for some time we found no improvement in the operation of the machine; in fact it appeared to be laboring and the temperature of the discharge air was very high. The cylinder heads were then removed, the valves taken out and a careful examination made. The cylinder wall seemed to have a sticky, plastic coating; the air passages and discharge cavity of the cylinder showed signs of dark deposits, while the faces of the valve seats were covered with a black, hard coating. This hard formation caused the valves, to leak, hence the increased temperature of the discharge air, and the sticky coating was responsible for the increased friction. The representative's attention was called to this condition, and he suggested that a little lighter oil be used, this time of 27½ Baumé gravity, flash point 450 deg. F., burning point 500 deg. F., and vicosity about 125 S. at 212 deg. F. On being asked if he did not think this was too heavy for air-cylinder lubrication he assured us it was not and stated that in order to withstand the high temperature of the compressed air it was necessary to have a rather low-gravity and high-vicosity oil with a flash point above the temperature of the air.

After using this oil for some weeks another examination was made, and while the cylinder wall appeared considerably better the valve passages and discharge cavities of the cylinder were badly coated with a hard deposit. The trouble was again brought to the attention of the expert and he suggested that we reduce the amount fed into the cylinder. This was done with great care until we were only using three drops a minute in a 14 x14-in. cylinder running at 150 r.p.m., but even under this condition deposits in the valve passages and the discharge cavities of the cylinder continued to form as long as we used this oil.

Several months after the expert's attention was again called to the condition experienced with his oil. In regard to the amount we were feeding into this cylinder he said this was reduced to a point that he thought was the minimum. His reason for the formation in the passages was that the residuum of all oils is carbon, and that is was no doubt due to carbon deposits. He assured us that the oil he had recommended was the best procurable for the purpose, and that we should continue to use it without fear of trouble, which we did. However, the formation in the discharge pas-

sages seemed to be building up rapidly despite the fact that we were feeding but a small quantity of oil into the cylinder. The formation had collected to such an extent that it was necessary to clean the passages in order to avoid an explosion. Some of the removed material was analyzed and found to contain about 1.5 per cent. free oil, 11 per cent. rust, 5 per cent. decomposed oil, 30 per cent. mineral ash, 10 per cent. coal dust and the remainder foreign matter, or residuum. A further investigation showed that our intake was exposed to coal dust, mineral ash, shavings, water, etc., as well as some air.

After cleaning the compressor and safeguarding the intake against dirt and dust, we procured another grade of oil which we believed was more suitable for the work, as we had investigated and studied the question in the meantime. This oil was of 31 Baumé gravity, flash point 375 deg. F., burning point 420 deg. F. and vicosity 200 S. at 100 deg. F. We started by feeding three drops a minute. Finding the cylinder copiously oiled the feed was reduced to two drops. The compressor was operated in this condition for a long time with practically no trouble from carbon deposits.

Experiencing such good results from this light oil and by this time disbelieving the virtues claimed for the low gravity, high flash point and heavy vicosity, we were prompted to try another grade of oil and selected one having a gravity of 33 Baumé, flash point of 380 deg. F., fire test of 420 deg. F., and viscosity of 140 S. at 100 deg. F. The same quantity was used as before, namely, two drops a minute in a 14 x 14 cylinder running at 150 r.p.m. This oil was used for years without any trouble in respect to lubrication, valve leekage and carbon deposits—in fact it proved to be very satisfactory in every way.

The oil representative made his regular calls on us and each time we told him what we were doing. He assured us we were on the wrong track and that sooner or later would get into trouble, but after continued tests and very careful observation of all conditions, we are satisfied that the latter oil is the most suitable for air-cylinder lubrication when working against 100 lb. pressure, either single or two stage.

One day an old friend called, who was also an expert for an oil company. On being told our experience with air-cylinder lubrication he too assured us that we were using the wrong oil and said, "You know you get not less than 400 deg. F.in your air cylinder when working against 100-lb single stage." With this I agreed. I then asked him how he knew we were wrong, and what means he employed for ascertaining the proper grade of oil for air-cylinder lubrication. He then explained to us the method his company's engineers use in determining the proper oil for different kinds of service. He said:

"Since you have agreed that the temperature of the air is 400 deg., our tests would be conducted as follows: Take a block of cast iron 6 in. or 8 in. square and 2 in. thick; place this block in a layer of sand in a shallow iron pan, pack the sand closely around the cast-iron block, then put a gas burner under the pan and turn on the heat slowly. The top surface of this block is polished and has a drilled hole, and into the hole a thermometer is inserted. Heavy steam-cylinder oil is poured into the hole around the thermometer bulb so as to make a close heat contact. When the thermometer rises to 400 deg. lower your gas burner until the thermometer remains at 400 deg. Then take your different samples, dip the point of a lead pencil into the oil, hold the pencil 2 in. from the surface of this iron block and allow a drop to fall on the hot polished surface.

A HIGHER GRADE OF OIL

"When such a test is made with the grade of oil from which you say you are getting successful results it is found the drop spreads out to about 1⅛ in. in diameter, smokes a little, dries up, and is evaporated in 10 sec. time, leaving the surface perfectly dry. With a higher grade of oil having a flash point of 450 deg. F. and heavy viscosity, when the drop falls on the surface of this polished block it spreads out to about 1¼ in. in diameter, smokes a little, but, after 5 min. the surface is still oily. Thus we have proof that this is the proper oil to withstand such service as you get in your air-compressor cylinder."

I asked him what he thought the temperature of the surface of the cylinder wall was when the air in the cylinder is 400 deg. F. He hesitated, then said he believed it would be about 25 deg. F. less than the temperature of the air. I disagreed, saying this did not seem right, as the water-jacketed wall should be much cooler than the air. We went into the office and consulted some authorities. We

found some tests had been made abroad on the temperature of the cylinder walls in an internal-combustion engine where, with an explosion temperature of 2700 deg. F. and an average temperature through the cycle of 950 deg. F. and the water in the jacket at 200 deg. F., the inside surface of the cylinder wall did not go above 267 deg. F. When shown these figures my friend was nearly speechless and admitted that he had never thought that the temperature of the wall of an internal-combustion engine cylinder with an explosion temperature so high could remain so cool. However, as the character of the authority was such that is could not be questioned it was accepted by the oil expert. I then asked what he thought the temperature of the air-cylinder wall should be when the air does not exceed 400 deg. F. He said he did not know, but did not believe it would be very much above the temperature of the water in the jacket.

As a matter of fact, the temperature of the inside of the cylinder wall of a water-jacketed cylinder is not more than 30 deg. F. higher than the temperature of the jacket water, as long as the water does not boil; and since this is so, what is the use of using oils of low gravity, high fire test and high viscosity to meet a condition such as this one now appears to be? The temperature of the inside surface of the cylinder wall on an air compressor is very little, if any, above the temperature of the surface in the main bearing of the ordinary Corliss engine.

From this it appears that the expert who lays stress on high viscosity and flash point has not considered the true conditions. We have shown that the cause of carbon deposits in the passages of an air-cylinder is not always entirely chargeable to the residuum of oil, but in many instances is due to using an oil of too heavy body, which adheres to the passages of the cylinder, and furthermore, when the inlet is not properly protected from foreign matter, material such as coal dust, mineral ash, shavings, waste, etc., is drawn into the cylinder and deposited on the sticky surfaces coated with this heavy oil. This foreign matter, with the additional oil, gradually builds up until the passages become choked, and the air valves begin to leak for some reason, thus increasing the temperature, until finally it sometimes reaches a point as high as 500 deg. F. when compressing to 100 lb. single stage. It there are many shavings or very much coal dust deposited in the passages, it is apt to char and become incandescent. When it does, the temperature of the air rises very rapidly and, as a consequence, the pressure increases quickly to a point beyond the strength of the receiver and results in what is generally called an explosion.

In my opinion no violent explosion ever takes place in an ordinary air compressor unless kerosene, gasoline or some such material is introduced.

I had an experience some years ago with a two-stage compressor where the intake had been neglected and also the wrong grade and quantity of oil had been used; the high-pressure discharge valve became leaky, allowing the air to churn in and out of the cylinder at each stroke and heating it until it became so hot that the heavy deposits in the passages actually took fire. The whole system burned out like a chimney of an old-time wood stove. Fortunately there was no explosion because the safety valve on the receiver relieved the sudden pressure caused by the burning material in the discharge passages and the compressor was promptly shut down.

From the foregoing it will be understood that in the selection of an oil for air-cylinder lubrication nothing should be used but a pure mineral product having a gravity of from 31 to 33 Baumé, a flash point of 375 to 390 deg. F. and a viscosity of 140 to 150 S. at 100 deg. F. Under no circumstances should a heavy grade be used despite any claim made by the oil salesmen of the virtues of heavy viscosities or high flash points. It should also be borne in mind that when the surface of the cylinder wall is once glazed over, very little oil is required to properly and adequately lubricate the working surfaces.

The film of oil on the cylinder wall is understood to be less than 0.00025 in. in thickness, and since in the operation of compressing air there is practically no moisture the piston rides back and forth on this film and requires very little oil to be added in order to maintain the quantity required. Should a greater amount of oil be used than just enough to keep up the required film it will be plowed up ahead of the piston and be forced through the valves and into the cylinder cavities, where it will collect in the low places and solidify by rea-

son of being mixed with foreign matter taken in through the inlet.

As has been shown, a 14x14-in. cylinder can be adequately lubricated with two drops of oil a minute when the compressor is operated at 150 r.p.m, being the equivalent of one drop of oil for each 600 sq. ft. of cylinder surface swept by the piston. The oil here referred to was of paraffine base. However, I believe that an oil of about the same consistency, refined from an asphalt base, would serve as well if not better.—*American Machinist.*

PNEUMATIC CONVEYANCE OF DRY SAND

The illustrations here reproduced from a recent issue of *Electric Railway Journal* show the essential features of a sand car built by the United Railways of St. Louis. From this car the sand is unloaded by air pressure, and the results have been very gratifying both in the amount of labor saved and also in the time reduction. With a crew of two men the car will deliver about 1,000 cu. ft. of sand per day, as compared with 400 cu. ft. per day with four men when unloaded manually. The method employed is of course not original but its application of this case exemplifies good practice. The body of the car consists of a 15-in. 60-lb. I-beam frame mounted on the company's standard diamond-frame truck and driven by four 50- hp. Westinghouse motors. The car is 30 ft. long over the bumpers, and approximately 8 ft. 6 in. wide.

The large sand tank, which is 12 ft. in diameter and has a capacity of 360 cu. ft., is

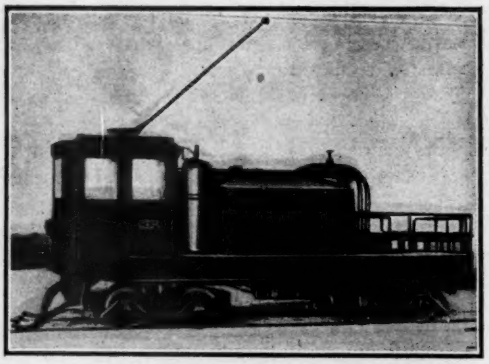


FIG. I

placed in the middle of the car. In the concave bottom of this tank there is an opening to which is riveted a T-shaped casting. A 4-in. discharge pipe leads from one side of this casting and extends vertically up the back of the tank and over the top by means of two large radius bends. A wire-bound rubber hose is attached to the free end of this pipe. There is a 4-in. gate valve at the end and a swivel joint between the bends so that the pipe may be turned at any angle. Directly opposite this opening in the casting is a 1¼-in. pipe leading to the compressed-air equipment.

The compressed-air equipment consists of two type DH-25 Westinghouse motor-driven compressors capable of delivering 25 cu. ft. of air per minute at 90 lb. pressure, and two 18-in. by 72-in. air reservoirs which are connected to the sand tank through a quick-opening valve. The compressors are located in the

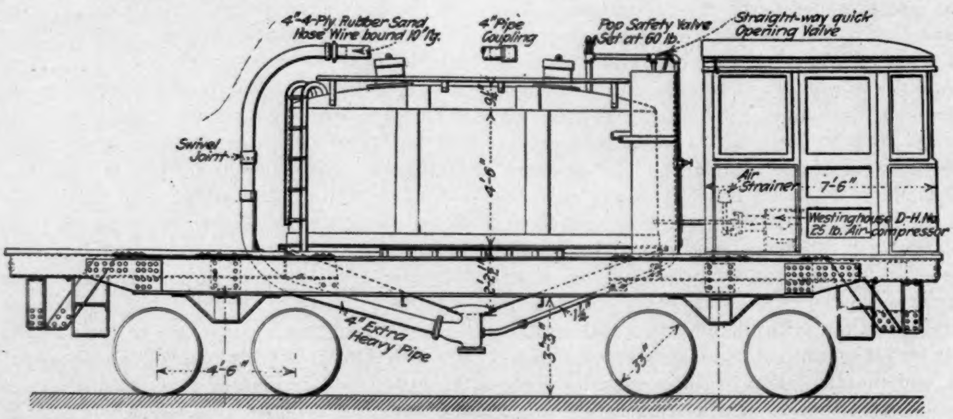
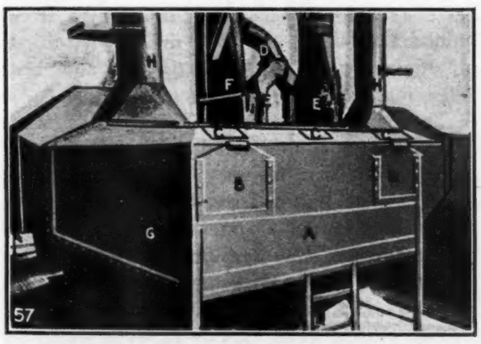


FIG. 2

driving cab which takes up 7 ft. 6 in. of space at one end of the car. This cab has a 30-in. sliding door in the rear end and is 7 ft. 3 in. high, giving a total height from top of rail of 11 ft. 10$\frac{3}{4}$ in. The air reservoirs are located between the cab and the tank. After having been in operation some time, it was found to be advantageous to install two additional air reservoirs of the same size and so arranged with check valves that a back pressure of 20 lb. is always upon the compressors. This is to prevent the compressors from racing when the pressure in the reservoirs is suddenly thrown into the sand tank.

The operation of the car is very simple. The car is loaded at the dry sand plant through the two openings in the top of the sand tank. The caps are screwed on and the car proceeds to the bins. Pressure is pumped up in the reservoirs while the car is traveling, and upon arrival is turned on to the sand through the quick opening valve at a pressure of from 25 to 60 lb. per square inch. The sand is forced down into the T shaped casting at the bottom of the tank and, assisted by air pressure entering the T through the 1$\frac{1}{4}$ in. pipe, is forced up and out through the stand pipe and hose. Sand begins to flow at 25 lb. pressure, but operates best at about 40 lb. The tank is designed for 60 lb. working pressure, and is protected by a safety valve at the top.



A SPECIAL SAND BLAST MACHINE

An elaborate serial article describing the manufacture of the Comptometer current in the *American Machinist* contains the following account of the sand blast apparatus employed:

A number of parts must be sandblasted, and as no satisfactory machines for this work could be purchased, the one here shown was designed and built.

The body of the machine *A* carries a shaft with a set of pulleys at each end, over which pass endless rubber belts for carrying the work under the blast nozzles. Under the machine is a hopper, through which the spent sand runs by gravity to a storage bin from which it is carried by elevators to a supply bin overhead. Sliding doors at *B* permit work to be held under the blasts by hand, and glass windows at *C* allow the workman to watch the progress of the work without risk to eyes and lungs.

The sand runs from the overhead supply bin to the nozzles through the spout *D* to the gates *E*, which have screw adjustments and distribute the sand in a long, flat stream under the air nozzles *F*. An opening in the machine body at *G* is closed by a canvas curtain and permits work being placed on the endless belts. The exhaust pipes *H* carry off the spent air and fine dust, leaving the returned sand always clean and ready for use. These machines use from 12 to 14 oz. air pressure.

MEXICANS ARE NOT HUNS

To the honour of Mexico, it should be said that during the whole period of her troubles, the property of foreign investors has suffered but little injury. On the various mines, in the aggregate, machinery which has cost some hundreds of thousands of pounds, has been erected, and we have yet to learn that any of it has been damaged to any serious extent. In other words, the Mexicans have shown an example to the Huns which the latter may, in a day that is coming, regret they did not follow. The mines, therefore, are ready, one and all, to go to work, and some have already done so, though, as pointed out, conditions have not been wholly stabilized.—*Mining World*, London.

FIGURES HARD TO GRASP

The Entente Allies—excluding Russia and including only those British dominions which are self-governing, and only the United States proper—have 11,000,000 square miles of territory, 303,000,000 people and $495,000,000,000 of natural wealth. The Central Powers have 1,250,000 square miles of territory, 147,000,000 people, and $134,000,000,000 of national wealth. The Entente owe an aggregate debt of $69,000,000,000, which is about 14 per cent. of their total assets. The Central Powers owe $37,000,000,000, or 28 per cent., of their national wealth.

THE CEMENT GUN FIREPROOFS A MINE SHAFT*

By E. M. Norris

In the summer of 1917 it was decided to fireproof the tramway hoisting shaft of the Anaconda Copper Mining Co. at Butte, Mont. The shaft has three hoisting compartments and one pump compartment; it is timbered with 12 x12-in. fir timber, and is 2475 ft. deep. Subsidence and displacement of the surrounding country rock had produced exceedingly heavy ground, and had carried the shaft out of line, in several places, by as much as 2 ft. displacement. Constant repairing and realigning of the timbers had been necessary in order to maintain clearance for the cages. The most feasible method of fireproofing, therefore, seemed to be to cover the timbers with a coat of concrete applied with the cement gun.

The cement gun, which is operated by compressed air at ordinary mine pressures, feeds a mixture of sand and cement through a hose to a nozzle having a water connection. The mortar in fluid form is thus sprayed upon the prepared surface in thin layers, which can be built up to any desired thickness. The cement gun can be set up at any convenient point; satisfactory results have been obtained with the nozzle a distance of 500ft. from the gun.

The shaft was thoroughly overhauled and the timbers were put in the best possible state of repair. Between the 1000 and the 1400 levels, much loose ground lay against the shaft timbers on the north side; this was breast-boarded back and a 30-in. reinforced-concrete retaining wall was erected, leaving a space of 12 in. outisde the shaft timbers to allow for future movements of the ground. For convenience in handling men and materials, it was rearranged to concrete the auxiliary hoisting-first, using the cages of the main hoist to serve the cementing crews. The auxiliary cage was then available while the remainder of the shaft was being concreted.

A tight partition of 2-in. plank was erected between the auxiliary and the adjoining hoisting compartments, for beter protection of men riding on the cages. The application of concrete made this partition air-tight, which should prove a valuable feature of the fireproofing measures. It was considered necessary to guard against the spreading of fire in the timbers behind the concrete covering, as once happened in a Michigan shaft. A set of shaft lagging was therefore removed just above and below each station, and a concrete casing was built back to the walls so as to form an air-tight seal at these points. Another seal was made at the rear end of each station in a similar manner as illustrated.

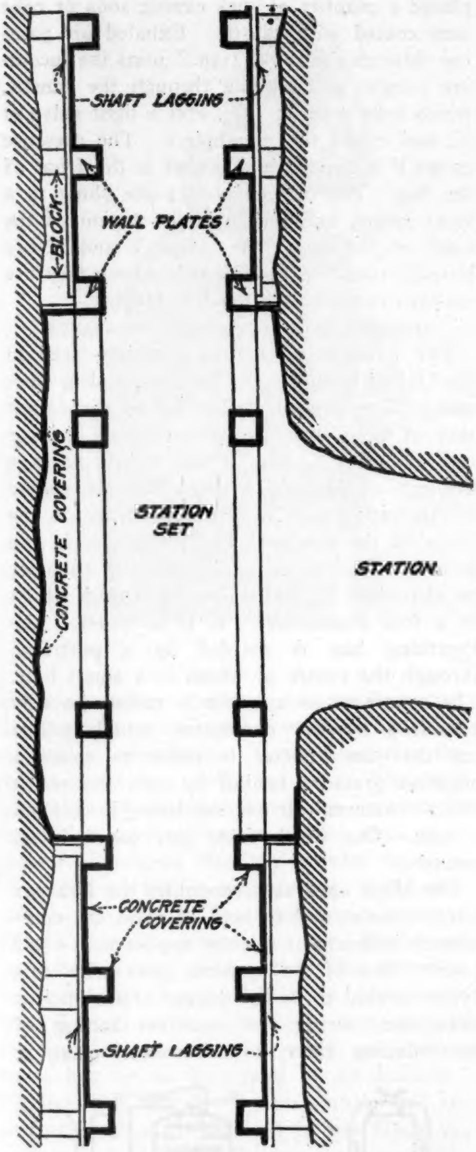
CONCRETE REINFORCED BY METAL LATH

Experiments were made to determine whether reinforcing material was necessary to hold the concrete to the timber and, if so, what kind of material was best. It was found that if the timbers were wet down thoroughly the concrete would stick without reinforcement, but subsequent distortion of the timbers caused the concrete coating to shell off in large slabs. Tests of chicken wire, herring-bone metal lath, and diamond-mesh metal lath showed that all these materials made equally satisfactory reinforcement for the concrete coating, the only difference being the matter of cost. Chicken wire was the cheapest to buy, but the labor of nailing it to the timbers was much greater than with metal lath. After using several thousand square yards of each of these materials, it was found that the 27-gage diamond-mesh metal lath, 24 by 96 -in. was the most economical and satisfactory reinforcing material; it was also determined that 6-d wire nails driven two-thirds of their length into the timber, and bent over, made the best fasteners.

The comparments to be concreted were covered with timber bulkheads at each level and lathing was begun. The lathing crews consisted of six men to a lift, two or more lifts being lathed at one time, according to the number of men available. With the diamond-mesh material the rate of lathing was 225 sq.ft. per man per 8-hour shift.

Two cement guns, type N-L, were set up on mine trucks so that they could be pushed on the cages and moved from level to level as required. With an air pressure of 75 lb. per sq.in. it was found that 200 ft. above, and 75 ft. below, were the greatest vertical distances from the gun at which satisfactory work could be done with the nozzle. Where lifts greater than 275 ft. ocurred, it was necessary to set the guns on bulkheads in the shaft. The sand

*Paper before the Colorado Meeting of the American Institute of Mining Engineers.



SECTION OF SHAFT

was dried, when necessary and screened through a ¼in. screen. It was then mixed with cement, on the surface, and put into old cement sacks for convenience in handling. It was found necessary to screen the cement also, as lumps blocked the discharge and caused frequent delays. Mixtures of 3, 3½, and 4 parts of sand to 1 of cement were tried. Where thin coatings (¾in. or less) were applied, the 3 to 1 mixture was the most satisfactory, as it went on more evenly and formed a tougher coating.

Each crew consisted of four men, two feeding the gun, and two on the nozzle. The nozzle-men worked from stage planks in the shaft and were provided with rubber gloves, safety goggles, and respirators. The surface to be coated was washed off thoroughly with water sprays. Concrete was applied in two successive layers ¼ in. thick. After the coating had become firm, it was sprinkled often enough to keep it damp for several days. It was found that a gun crew could cover from 800 to 1200 sq.ft. of surface in eight hours. Repairs on the gun were slight, wear being taken by the rubber liners. Nozzle liners lasted 48 hours, discharge liners about six weeks, and the cement hose several months. The shaft and station timbers were repaired and concreted from surface to the 2000-level in 94 days, 175,465 sq.ft. of surface being covered. The average number of men employed was 54, including superintendence and all surface labor connected with the job. Material used was 6102 sacks cement, 1500 tons sand, 165,495 sq.ft. of lathing, 2600 lb. nails and staples.

FIRE TEST SHOWS UTILITY

Four samples were prepared for fire test. Pine timbers 6 by 10 in. by 5 ft. were covered on all sides with lathing; three pieces were covered with chicken wire and one with metal lath. These timbers were then coated with ½ in. of concrete put on with the cement gun. Three of the samples were sprinkled daily for three days; the fourth was not sprinkled. After six days of hardening, the samples were placed in a large bonfire, until the concrete coating was heated to a dull red. The sample that had not been sprinkled shelled off with loud explosions, but the others were not affected. After 30 minutes the samples were pulled out and allowed to cool. Inspection showed that the only apparent effect of the baking was a slight charring of the wood on the edges, where the concrete had cracked while drying.

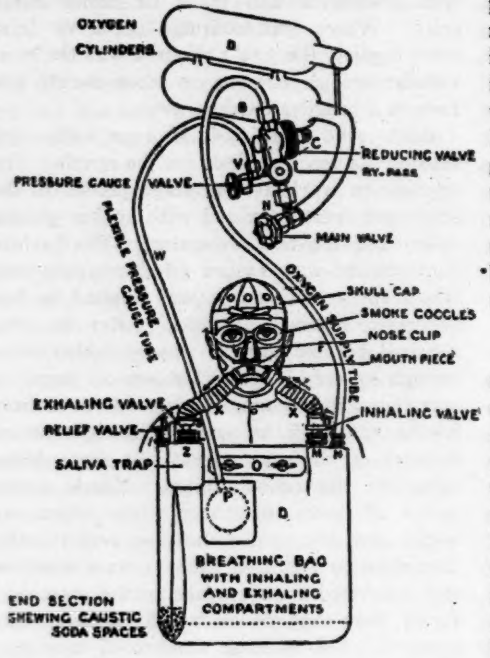


FIG. 1

MINE RESCUE APPARATUS

In 1917 a committee was appointed by the Advisory Council for Scientific and Industrial Research to investigate the types of breathing apparatus used in coal mines. The report of the first year's investigations, which has recently been published, calls attention to certain serious defects in existing mine apparatus, and in the training of men in the use of such appliances. Passing to a description of the various appliances in use the report gives detailed particulars of each apparatus.

PROTO APPARATUS

The present day Proto apparatus, shown diagramatically in Fig. 1, has developed from the original design of Fleuss, whose first patents are dated 1879. The circulation is effected by the lungs of the wearer, breathing taking place wholly through the mouth, the nose being closed by a clip. The two cylinders B contain 280 litres of oxygen at 120 atmospheres. The reducing valve C allows a constant flow of two litres per minute into the breathing circuit. The oxygen, opening a light mica non-return valve at N, enters the breathing bag D. This bag is provided with a partition descending nearly to the bottom, and in the bottom is placed a quantity of stick caustic soda or coke nuts coated with caustic. Exhaled air passing through the saliva trap Z joins the incoming oxygen and passing through the caustic, which robs it of its CO_2, lifts a light valve at N, and enters the mouthpiece. The pressure gauge P is carried in a pocket in the front of the bag. The oxygen bottles are slung in a stout jacket, and repose in the region of the small of the back; the valves V and H are brought round to the left side where they are readily controlled by the left hand.

THE DRAEGER AND THE MECO APPARATUS

The Draeger apparatus is widely used in the United Kingdom, in America, and in Germany. The oxygen is supplied at a constant rate of two litres per minute from one or two cylinders C. Fig, 2, and by its passage through an injector I keeps the air supply in circulation without any dependence on the lungs of the wearer. The purifier is in the form of a cartridge carried in the chamber or chambers P, and can be changed whilst in a foul atmosphere. K is a cooler. The breathing bag is divided by a partition, through the centre of which is a small hole. The apparatus as a whole is rather severely criticised by the committee, which points out that the injector is liable to cause a negative pressure behind it, with the result that the external air may be drawn in through a leak. One death from this cause is on record.

The Meco apparatus resembles the Draeger fairly closely, and to both of them the committee's criticism of injector applies with equal force. One of the gravest risks with this device is said to be the danger of insufficient circulation, owing "to incorrect setting of the reducing valve, to the partial clogging

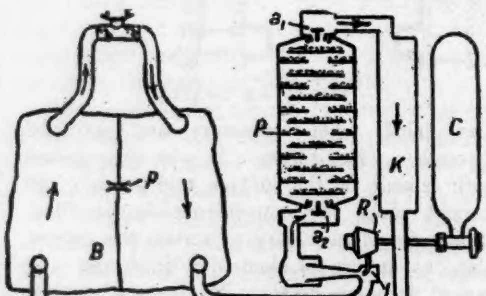


FIG. 2

FIG. 3

of the secondary nozzle, to leakage from the circuit, to the accumulation of water or other material in the pipes, or to an increase in the resistance of the purifier. . . . When the wearer of an injection apparatus fitted with inspiration and expiration valves requires a greater air-volume than the injector supplies, he exhausts the inspirator bag and over-fills the expiratory; breathing becomes more difficult, until eventually the inspiration bag flattens in mid-breath. The sensation of the lungs being choked in this manner is extremely distressing and is apt to produce panic, and such an occurrence has to be prevented at all hazards." To meet this difficulty the inspiratory and expiratory valves are omitted in the Meco apparatus, whilst in the Draeger apparatus either the two compartments are united by a small hole or the expiratory valve is omitted. The object in any one of these cases is to allow the wearer to re-breathe the exhaled air. "We look," says the report, "upon these expedients with the gravest suspicion," and in conclusion of the whole matter says "there is no gainsaying that the injector as an adjunct to breathing apparatus, is a grave source of danger. To do away with it entirely is the only satisfactory solution of the problem to which it gives rise."

THE WEG APPARATUS

This apparatus derives its name from the initials of its inventor, Sir W. E. Garforth. Side and back views are shown in Fig. 3. There are two curved oxygen bottles, which are carried at the sides of the wearer. They are connected by a narrow tube and contain 300 litres at 150 atmospheres. The two valves *c* and *c* are opened together; G is the pressure gauge, which is provided with a mirror which allows the wearer to take a reading by reflection. The breathing bag is carried on the back and the pipes from it are carried over the head to the mask. The most distinctive feature of the appliance is a delicate reducing valve R, which has a large diaphragm, and is adjusted to open during inhalation and close on exhalation, the object being to provide automatically for the varying oxygen consumption of the lungs. In recent designs two of these "lung governed valves" in series are provided.

LIQUID AIR APPLIANCES

In the first apparatus (the Ærolith) to use liquid air there was no purifier, the exhaled air was mixed with evaporated liquid air and breathed again; the formation of ice led to

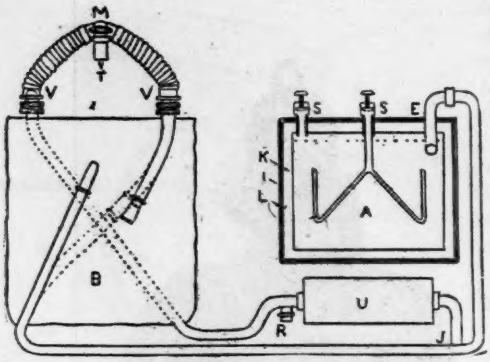


FIG. 4

excessive resistance in the earlier models. In the Aerophor a purifier is provided—see U in Fig. 4. The liquid air container A is carried on the back. It is a metal receptacle packed with asbestos wool and is filled through a central opening by pouring in eight or ten pounds of liquid air from a large Dewar flask. The receptacle is well insulated but receives enough heat to cause gentle evaporation. At first more air is given off than the wearer needs; some of it then passes by the branch pipe, J, and entering the purifier escapes by the valve R, through which exhalation also takes place. Later, when the evaporation is less active R closes and the exhaled air traverses the purifier, and joins the new air on its direct course to the breathing bag. Owing to the early excess, it is possible to couple a pipe and mouthpiece to R and thus supply two men from one apparatus for two hours or so. Either a mask, or a mouthpiece and nose clip may be employed.

THE TISSOT AND GIBBS' APPARATUS

In the Tissot appliance which is largely used in the French mines and by the French army, both the breathing bag and the purifier are carried in a case on the back. This is the only apparatus, in which a liquid potash solution is employed. The lye is made just before use. The report draws attention to the disadvantages attaching to a liquid purifier and observes that as applied in this apparatus "it is not particularly effective in abstracting CO_2." To Dr. Tissot belongs the credit of first controlling the oxygen feed by means of an adjustable reducing valve manipulated by the wearer. The automatic relief valve on the breathing bag is novel, in that is is a slide valve operated by the inflation of the bag.

The Gibbs' apparatus, American, closely resemble the Tissot, but the purifier consists of caustic soda cast upon gauze. Garforth's principle of automatically controlling the discharge of oxygen according to the needs of the wearer is utilized, but instead of the discharge valve being operated by pressure difference, as in the Weg, it is opened mechanically by the partial collapse of the breathing bag, which is of the bellows pattern and is borne on the back. The apparatus has several ingenious features and is well spoken of in America.

THE PNEUMATOGEN

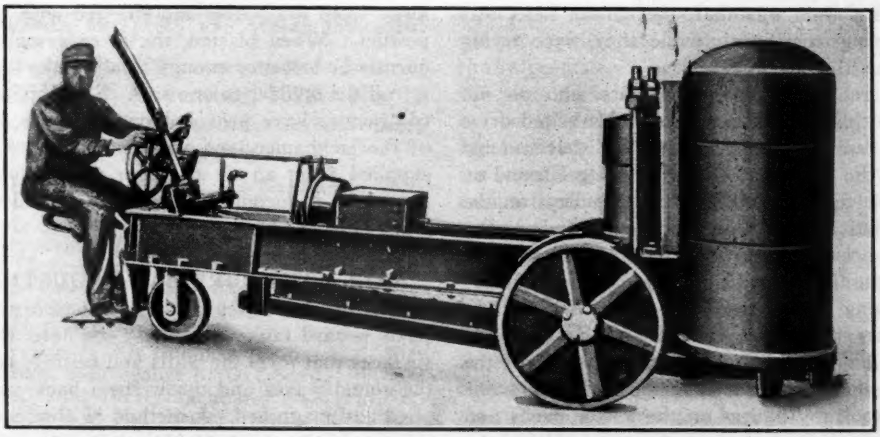
In this apparatus the exhaled air is regenerated by passing through cartridges of oxylith (potassium sodium peroxide). This substance is attacked by CO_2 and watery vapour with the liberation of about the same volume of oxygen as the CO_2 and water contain. Whilst the apparatus has the advantage of small weight the development of excessive resistance and heat has been inimical to its success.

RECOMMENDATIONS

The second part of the report is given up to a critical examination of the different appliances examined and to recommendations. After alluding to the fact that failures of rescue apparatus are due to preventable causes, the report proposed that no apparatus should be employed without official approval, and that an inspector of Rescue Training and Organisation should be appointed. The causes of failure are then discussed in detail and may be briefly enumerated. (1) A dangerous proportion of CO_2 may accumulate in the air breathed. The reporters are strongly of opinion that "a purifier should be so constructed that it will outlast the oxygen supply." (2) The oxygen supply may fall short—generally owing to leakage. (3) The oxygen percentage in the air breathed may fall dangerously low. This risk may be minimised if both the breathing bag and the wearer's lungs are washed out with pure oxygen at the start, a course which the committee recommends. (4) The apparatus may leak, allowing poisonous gasses to enter. The chief source of danger is a leaky mouthpiece. (5) The breathing bag may become so empty that a full

breath cannot be drawn from it. (6) The apparatus may fail owing to excessive resistance to breathing. (7) The temperature of the inspired air may become excessive. (8) The wearer may be overcome by a rise in his own body temperature. (9) The apparatus may fail through faulty construction. Under this last heading, a great number of details are discussed, and in the first place the recommendation is made that "the existing types of helmet and face mask be abolished in so far as self-contained apparatus is concerned." They suffer from the defect that they cannot be made air-tight, particularly on men with hairy faces or sunken cheeks or cheeks that draw in much on inhalation. "The mouthpiece is the only attachment independent of such consideration, and the only one on which reliance can be placed." Amongst other recommendations with which we need not deal we notice that an official requirement as to oxygen purity and that compulsory analysis of oxygen are advocated.

The above we reproduce, with some abbreviation, from *The Engineer*, London.



AIR OPERATED TRUCK FOR MALLEABLE IRON OVENS

The illustration above shows a truck built by the Brown Specialty Machinery Company, Chicago, for charging stacks of castings into malleable iron annealing ovens. It is operated by compressed air supplied by a hose connected with the foundry air service. As will be seen, the main frame consists of two steel channels from which are suspended the 4-inch steel elevating and lowering arms that are equipped with removable cast steel tangs for picking up the sacks of charging boxes. These tangs may be replaced readily when worn. The arms are raised by an air cylinder controlled from the operator's seat. A reversing air motor drives the truck, through a set of reduction gears and a standard motor truck differential, to pinions engaging in the internal gears on the driving wheels. The truck is guided by a standard motor truck steering worm, so arranged that the truck can turn in its own length. The air hose is suspended overhead. The air consumption is only 80 cubic feet per minute and the operating speed 90 to 120 feet per minute.

COMPRESSOR TROUBLE—COMPRESSOR NOT TO BLAME

We use compressed air to a very large extent. One of the compressors is in my department and has been a source of endless trouble and expense. At the time I got to work on it it was a sorry-looking outfit. The pulleys on the jackshaft had been lagged with belting to help them pull and to make the belts run to the center. The belts were really just some pieces of greasy hides about of an even width, and black with oil, belt dressing and rosin. One of the pulleys had been partly wrecked by the heavy work and the grease, and two piles of the rim from either side had been torn off.

Here was a chance for a little study. Pulleys don't act that way in general, and belts don't get greasy unless the oil is allowed to get to them. It was estimated that it took 40-

h.p. to run the compressor, and the lineshaft from which it was driven had 75-h.p. hung on it and was driven by a 50-h.p. motor. Add the compressor to that, and we had over 100 per cent. overload. Now, if the load had been arranged in good shape the result would have been the stopping of the motor and the blowing out of a fuse, or else the belts would have run off; the latter is what happened.

We are blessed (?) with a departmental supervision of mechanics, and if it were not so expensive it would really be funny. About the time I got to this compressor trouble there were some eight or nine officials to pass on the matter, and the last one that I got my instructions from simply told me to see what the trouble was, and he added: "By all means get the compressor going."

About the first thing to do in a case of this kind is to check up. See if you have on hand what all the elaborate reports say you have; and then see if what does check up is of the right size. The first day I was in this shop was the last day they had been trying to run this compressor. I usually use my eyes and take stock of my surroundings, and one of the things I saw was that one of the belts was fluttering very much while they were trying to run the machine.

There are a few millwrights who do not know that in the case of a double-belted drive both pulleys on the driver and driven must be of the same size. The first thing I found on this drive was that the driving pulleys on the jackshaft were ¾-in. different in diameter. That accounted for the fluttering of the belt and the fact that one pulley was torn loose in trying to run the belts.

After a couple of days arguing with the "man higher up," I got two new pulleys of the same diameter and two new belts, and the boss took my figures on the power needs and let me put in a separate motor to drive the compressor—and then the old trouble about the greasy belts turned up. The machine had a splash system for oiling and the oil ran out on one of the journals, down the hub of the pulley and went all over everything in a shower. That was a defect in the oiling system of the machine, which was corrected by putting a spring near the hub and holding a leather point at hub to catch the drip and turn it down into the oilpan. It was crude but effective, and now the compressor is running as it was intended to run, and without the oil bath that has been destroying belts and pulleys.—*R. W. J., Woodworker.*

DRILLING BOULDERS WITH JACKHAMER DRILLS

In overburden stripping on the Mesabi Range when the steam shovel encounters boulders too large to be loaded, they are rolled to one side of the cut and left until drilled by "single jackers." These "single jackers" work on contract and average about 15 ft. per shift in granite, states Mr. L. D. Davenport in the *Engineering and Mining Journal,* from which this note is taken. Blasting is done by the company powder man, using 60 per cent. dynamite. When a large boulder is partly uncovered in the bottom of a cut and projects so that it interferes with the shovel track or the jack-arms, there are several ways of removing it. One practice, formerly common but now seldom used, is to "bulldoze;" that is, to place 25 to 75 lb. of dynamite on the boulder and blast. Needless to say, this method frequently injured the shovel. Often a small "gopher" hole can be dug under the boulder on a side away from the shovel and charged with black powder. When blasted, the ground will frequently be loosened enough to allow the dipper to roll the boulder to one side. Some stripping contractors have provided one or more drills of the jackhamer type on each shovel. Air is supplied from an air pump or the compound pump on a locomotive, and the boulder is block holed.

HAIR MATS CURE BAD ACOUSTICS

Present day fireproof construction often tends toward faulty acoustics; the hard, flinty surfaces that form the walls and ceilings catch the sound waves and throw them back multiplied and magnified. A method of eliminating this trouble has been developed recently. This consists of the application of a scientifically constructed mat of woven hair to the ceiling and when necessary to other points. The millions of minute interstices of the mat absorb the sound waves in both direct and reflected action. The mat is covered in such a way to give the appearance of a pleasing and harmonious finished surface, without injuring the power of absorption. It in no way detracts from the architectural appearance or the decorative scheme.

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EVERYTHING PNEUMATIC

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CONTENTS

THE RAISING OF THE ST. PAUL

In these days, when events of world wide moment and interest crowd so closely upon each other as to constantly crowd the chronicler, the raising of the steamer St. Paul, of which we give a brief account in this issue, must slip into the past with much less notice than it deserves or than it would normally receive in times of peace. To those who give the achievement the slightest attention it speaks for itself as to the difficulty and magnitude of the problem, and of the resourceful ingenuity, the perseverance and, incidentally the expenditure which brought final success.

The sinking of such a ship, the manner of her sinking in the quiet harbor, the position in which she lay, and the oozy mud which engulfed her were all without precedent. It will be seen that after the conditions had been minutely investigated the problem involved was two-fold: first, to bring the ship to an approximately upright position, and then to cause her to float, the former being by far the most difficult part of the task. Words are all too weak to tell of the constant work of the divers, work of the most difficult and dangerous character, and deserving of vastly more individual recognition and recompense than is practically possible. The restricted space between the piers made it necesary to roll the ship in her bed of mud without at the same time causing her to slide laterally, and to secure this the ingenious device of the A frames provided most effectively. These A frames, with the pull of the hawser at the apex of each, doubled the leverage for rolling the ship over, while the effective lateral force upon the hull was minimized or mostly avoided by the angle of application. We may believe that there was little of guesswork or of cut-and-try in this operation, but that the work to be done and the forces applied were subjects of careful computation.

We feel especially warranted in speaking of the successful raising of the St. Paul on account of the important and most responsible part which compressed air played throughout the operations. The divers were busy on the job all the time and the air was constantly busy with them. The divers used jets of air, we are told, in blowing away the mud which interfered with some of their operations. The oxy-acetylene torch was used under water for cutting metal, and at depths greater than ever

before encountered. The oxygen used is, of course, a compressed air product, coming to us in the processes of manufacture by the way of liquid air. Compressed air was used also for controlling and determining the body of water in the forepeak of the ship during the refloating operation to maintain the longitudinal equilibrium.

The responsible engineers employed upon this work deserve high appreciation and unstinted praise, and it is to be hoped they receive also commensurate pecuniary recognition. The naval world is to be congratulated upon its acquisition of knowledge of the ways and means of marine salvage, and finally we may inquire how all this could have been done without the aid of compressed air.

A PERMANENT FILE FOR MINING RECORDS AND REPORTS

The exigencies of the war have brought out the necessity of having in Washington a permanent file containing detailed information relating to mines and mining companies, information that is not now available in any library but is needed by the Government in solving many problems relating to the betterment of the mineral industries. The Bureau of Mines, therefore, has undertaken the establishment of a file in which it intends to place not only data published in the annual reports of directors or mine managers to stockholders, but also reports of consulting engineers and the information supplied by mining companies in reply to questionnaires submitted to them. The reports of consulting engineers and any mining reports that the author or the operator wishes to have considered confidential will be so regarded; those that may be published later will bear a stipulated release date such as the author or operator may indicate.

In order that this information may be collected as rapidly as possible the Bureau of Mines invites mine operators, consulting engineers, and others to forward copies of reports that they may make on any mining property, these reports to be filed permanently with the bureau at Washington. Also the bureau asks all mining companies that issue an annual report to kindly favor the bureau with a copy for its files.

FOR CLEAN AIR FOR PNEUMATIC TOOLS

The following "Standard Practice Bulletin," issued by Division of Steel Ship Construction, United States Shipping Board Emergency Fleet Corporation, may be regarded as exceptionally good information and advice in the line indicated, and of course applicable wherever compressed air is used.

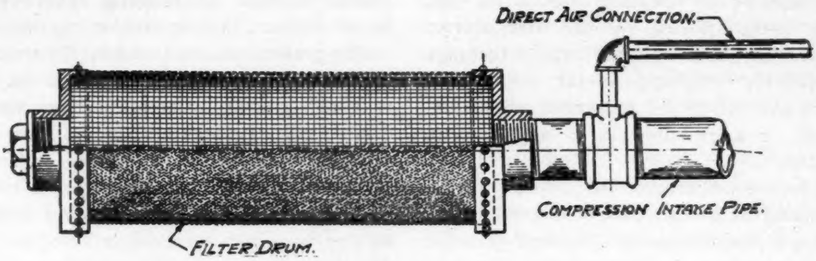
In view of the rather alarming rate of deterioration of air tools in shipyards under present operating conditions, and the inability of tool manufacturers to cope with the increasing demand for new tools and repair parts, it is important that very prompt and careful consideration should be given to every effective means of tool preservation.

A great deal has been said concerning the care and lubrication of pneumatic tools, inspection repairs, etc., which are of prime importance and should be followed up with increased emphasis, but for some reason little has been said, and practically nothing is being done, in the majority of shipyards, along the line of providing a clean air supply for the tools.

One of the simplest and most logical steps in an effort to prolong the life of tools, as well as the compressing equipment, would include a proper cleansing of the air supply at the compressor intake. Air taken in around the average manufacturing plant is anything but clean, even though the inlet is favorably located, and it is certain that the wear of pneumatic tools is very rapidly increased by dust and grit carried in the air, even when the tools are properly oiled.

Cloth filter screens, if properly designed and handled, will clean the air to a very large extent and can be made to serve the purpose in a very satisfactory way. The larger the filtering area, the closer the grade of cloth that can be used, and the more perfect the filtration. A very open cheese cloth, for instance, placed over an inlet strainer having not more than two or three times the area of the compressor suction pipe would do very little good while a closer woven and more substantial cloth placed over a much larger area will admit the air at a lower velocity, with no more resistance, and will clean it very much more thoroughly.

Careful tests made by the Standard Practice Branch of the Emergency Fleet Corpora-



FILTER FOR INTAKE AIR

tion show that air will pass through a light grade of unbleached muslin (common unbleached cotton cloth) at the rate of 100 cubic feet per minute per square foot of area, when subjected to a suction pressure, equal to ¼" static head of water, or the equivalent of approximately 1/100 of a pound. On account of the pulsating action of the air entering a compressor suction pipe, a light cotton cloth filter should be based on a velocity of not more than 1 foot per second or 60 cubic feet per minute per square foot of surface.

While the arrangement of a Compressor Intake Filter will depend, more or less, on the particular location and surroundings, it will always be possible to extend the suction pipe outside of the building in the form of a drum, constructed of heavy wire netting, as indicated by the accompanying sketch. The filter cloth can be placed around the drum, or series of drums, where large area is required.

If a supporting layer of poultry wire is secured around the outside of the cloth a large measure of cleaning can be very conveniently accomplished by admitting a sufficient volume of high pressure air directly into the intake pipe and reversing the flow through the cloth, at intervals when the compressor is not in operation.

An intake of this type should be protected by hood or shelter to keep the cloth dry.

A plain "U" tube draft gauge conveniently located and connected with the suction drum would indicate the resistance imposed by the cloth as it becomes clogged and call attention to the necessity of cleaning.

Air washers similar to those used for cleaning air for the ventilation of buildings should provide an ideal means for completely removing all dust and dirt from a compressor plant air supply.

While the humidity will be increased in the air before compression during certain weather conditions. It is interesting to note that no practical disadvantage will result, for the following reasons:

Air having a relative humidity of 15 per cent. or over, when compressed to 100 pounds and cooled to its original temperature, is fully saturated.

Since the air approaching the tools is usually saturated when no washer is used, the only difference will be the quantity of water condensed in the pipes.

The quantity of water condensed in the pipes under the present conditions, gives serious trouble if not properly provided for by the use of separators in the distributing system and an even greater quantity will give no trouble whatever if proper provision is made for its collection and disposal. Hence the difference, except in very dry weather, is a matter of quantity of water to be handled in the pipes and not a difference in the final humidity of the air at the tools.

If after-coolers are used, to precipitate the moisture at the power house after compression, the question becomes one of quantity of water precipitated and, except in very dry weather, conditions in the distributing lines will be identical either with or without air washing.

A study of the pneumatic tool situation at one of the large shipyards showed that the foreign matter carried in the air was of such a nature and extent as to practically preclude the use of the small wire gauze strainers, which belong in the air gun connections, on account of too frequent stoppage. The operators arbitrarily remove the strainers on account of the delays which they cause.

The repair room records in this plant show that more than 50 per cent. of all air tool

repairs consist of cleaning air parts and working parts affected by the dirt carried in the air. In like manner, a large percentage of compressor troubles, so far as the air cylinders and valves are concerned are directly caused or aggravated to a large extent, by the dirt.

There is every reason to believe that a proper cleansing of the air supply, together with separating tanks or chambers, located near the distributing headers for the removal of water, pipe scale, etc., (see Bulletin No. 4), will do much to relieve the rapid deterioration of air tools.

The emergency Fleet Corporation will be glad to co-operate with shipyards interested in this subject, through its Standard Practice Branch and to furnish more specific designs and information upon request.

OXY-ACETYLENE AND ELECTRIC WELDING IN RAILROAD SHOPS*

By A. F. Dyer.

Under the present hampering conditions both the electric and the oxy-acetylene processes have proved of great help in railroad repair shops. Seven years ago the Grand Trunk employed one man as an acetylene welder; now instead of one man we employ eighteen and often work overtime.

The low pressure acetylene gas system is used and the entire shops are piped for the acetylene, every other repair pit having a drop connection. In roundhouses we use Prest-O-Lite dissolved Acetylene in cylinders, which saves the expense of a generator and piping where the process is in use only occasionally.

Both the electric and the oxy-acetylene methods of welding have proved themselves fit to be ranked among the greatest time and labor savers introduced on the railroads for a long period. For instance, not long ago a locomotive with a broken frame would be held in the shops for several days, as it would take some time for removing the frame, having it welded in the smith shop and then machined and replaced. Now a frame 4 in. by 5 in. can be cut and welded in less than 14 hours. Frames, when worn by brake gear and stays, are built up and worn holes are plugged and welded instead of reaming them out to a larger size and thereby weakening the frame.

The present price of tool steel demands that none shall be wasted; therefore we use it down to the last inch by welding it to tire steel. Twist drills, taps and reamers, when broken near the socket end, are welded and put into use again. For this purpose we use either the electric or the gas process, but in both cases we use vanadium steel filling rods, as we find this gives the best results. Spokes of driving wheels are welded and flat spots on tires have been successfully welded when it was necessary to do so.

Up to the present time we have not had much success welding cast iron with the iron electrode although with the carbon a fair job can be done, but the gas is unquestionably the best for any of this work. We have successfully welded with oxy-acetylene, steam shovel engine frames and cylinders by welding in patches of cast iron where worn or broken. When our contract for shells was completed and the lathes that were used for this purpose were being overhauled, it was found that most of the V-slide beds were worn by the tool carriers. These were built up by the oxy-acetylene process, which saved machining the beds down as much as 3/8-in. in some cases.

In regard to boiler work, most of the welding is done with the iron electrode using a mild steel or Swedish iron as a filler. It is found that the electric process localizes the heat more than the gas, though it is the writer's opinior that the gas makes a closer and neater weld as all welds made by the electrode are more or less porous unless they are hammered. When patching a firebox it is better whenever possible to apply quarter or half side sheets in order to get the weld out of the fire. However well a patch is welded, it generally gives out in from twelve to eighteen months' service, and the same applies to cracks, whereas the quarter or half side sheets should last as long as the firebox.

When a nest of small cracks is found round the staybolts, the bolts are removed and the holes countersunk and welded. This method has been found to be very successful. Corner patches are welded by running the patch into the tube or back sheets, as the case may be, at the same time removing the flanges. If it is decided to do away with a number of tubes,

*Condensed from a paper before Canadian Railway Club.

plugs are welded in the holes. The holes are countersunk and the plugs are punched by a countersunk die which gives them the proper bevel for welding.

Superheater flues are being successfully welded to the tube sheet. The operators I am connected with prefer to have the flues belled and water in the boiler. This keep the tube sheet from heating, especially around the smaller tubes. The tubes are set in with copper ferrules set back 1/32 in. and the flues are belled out 3/16 in. to 7/32 in.; the small tubes, 3/16 in. The sheet is roughened all around the tubes and flues, and the oil is then burnt off with the oxy-acetylene flame and tubes and flues welded in with electrode, using 1/8 in. mild steel or Swedish iron. The latter is preferred if calking is needed.

A sample of an average day's work is as follows, for a gang of 12 men:—

14 rivet holes in smoke-box and 4 peg holes in foundation
10 tube holes in upper portion of firebox tube sheet.
2 air pipes which were worn through.
In the tool room:
1 ratchet for jack (2 teeth replaced).
1 gear spindle built up.
1 chuck screw, key end built up.
1 boring shaft built up from 2 1/2 in. to 2 3/4 in.
2 tool holders, rebuilt.
1 air hammer handle repaired.
6 teeth in lathe gear, built in.
1 cone, small end filled up solid.
2 1 1/4 in. holes in top rail of frame filled up.
4 cracks 18 in. long in right side sheet welded.
14 bottom tube holes welded up.
2 washout plug holes built up for re-tapping
Cut out frame for welding and started welding same.
Welded bushes in pony truck stays.
Cut out 3 sets of boiler tubes.
Cut out one set of superheater flues.
Build up calking edge of first hole.
Heated corners of tube sheet for closing.
Welded broken superheater damper bracket.
Built up reversing lever where worn.
Built up 2 side rods where worn.
Cut out 48 flexible staybolts in firebox.
Welded 2 cracks in throat sheet.
1 broken flange of air brake cylinder.

In addition to this list two men are engaged continuously on cutting around the shops.

For cutting steel and wrought iron the oxy-acetylene process has practically no competitor it being impossible with the carbon point to cut as fast or as fine and neatly as with the gas torch. For scrapping fireboxes and frames, the carbon point is cheaper to use if time is no object and labor is cheap.

The foregoing examples illustrate only a very small fraction of the uses to which the two methods of welding and cutting are being put in locomotive repair and machine shops, and fresh uses are being found for it every day. No roundhouse should be without an oxy-acetylene outfit, both for repair work and as a part of the wrecking outfit, and all large roundhouses should have both processes, as they would would pay for themselves over and over again.

In concluding, I would state that though there are many different opinions as to which is the best process, no shop is complete unless it has both equipments, although the gas has really the widest range.

Welding should not be treated as a side line of the machinists' or boilermakers' business, but should be treated as a trade in itself, as it really is, for it needs the entire concentration of a man's mind, careful study, plenty of practice and a conscientious man to make a welder.

Wherever possible a separate building or suitable space should be provided for bench work, and should be equipped with a suitable furnace for heating and annealing castings. There should also be plenty of floor room for charcoal fires for preheating cast iron jobs before welding.

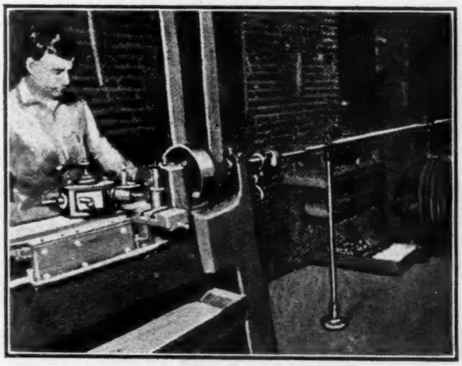


FIG. 1

AIR FEED ON TURRET LATHES

The compressed air feed for turret lathes as shown in Fig. 1, is an entirely automatic, yet very simple, effective and inexpensive device. The illustration shows a Bardons & Oliver machine at work in the Columbus Brass Co.'s shops at Columbus, Ohio. This concern has used the air feed attachment with satisfaction for nearly eight years. The rods being machined are about 14 feet long.

Directly in line with the lathe spindle, extending to the rear, is a piece of Shelby tubing, large enough in diameter to allow easy

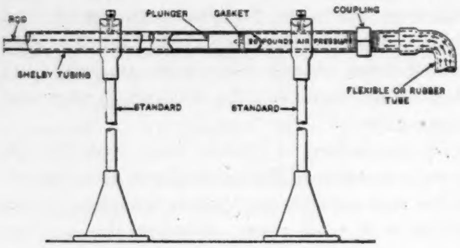


FIG. 2

movement for the rod, and extending about a foot beyond the end of the rod when it is held in the chuck. The tubing is supported by standards as required, and equipped at the rear end with an easily detached air coupling. One other part is required—a cold-rolled steel plunger, to one end of which a leather gasket is attached. The plunger fits loosely in the tubing, while the gasket, of course, is tight. The operator loads the lathe by pushing the rod through the tubing into the chuck, sliding in the plunger with the gasket outward and quickly coupling the air tube to the Shelby tubing. He then turns on the air, producing a constant pressure on the rod of twenty pounds per square inch, which forces it forward until it reaches the stop on the turret head. The rod is then chucked and ready to be machined.

To advance the rod, preparatory to starting a new piece, the operator simply releases the chuck, keeping the stop in its proper position, and the rod immediately advances to it. The lathe here shown is also equipped with an air chuck; hence the stock is both held and fed by air.—*Machinery*.

(*Continued from page 8936*)

work under fire in their cutting work, it is necessary to have additional trained men to take the place of those wounded or killed. As the work provided is extremely irregular, the welders can be employed on other work during quiet periods.

Department of Electricity.—The department of electricity employs oxy-acetylene welding mostly in connection with cracked frames of gasoline motors used to drive dynamos for generating electricity used at and near the front. On account of shell fire it is found impracticable to bring electric current from generating stations situated well to the rear, and therefore gasoline motor generating sets are employed locally. Two men and one set of apparatus take care of all the work necessary for an entire army of 200,000 or more men.

Railroad Work.—Narrow-gauge railroads, about 2 feet (60 cm.), are extensively used in hauling guns, ammunition supplies, and all kinds of material from the terminals of the broad-gauge railroads to the front, such narrow-gauge track often going to within 400 yards of the front trenches. The locomotives used are of two kinds, steam and gasoline, the former being used farther to the rear, while the gasoline motors are used near the front, where they are operated at night. The cars are usually of steel and hung very low. This equipment is broken and damaged through actual hard wear and frequently also by shell fire. It is here that the oxy-acetylene process is used not only for welding broken parts, but also for cutting away parts badly damaged by shell fire. At the repair yards two sets of apparatus, one stationary and the other portable, are provided so that large pieces, such as cars, etc., which can not be brought into the welding hut, can be repaired in the open.

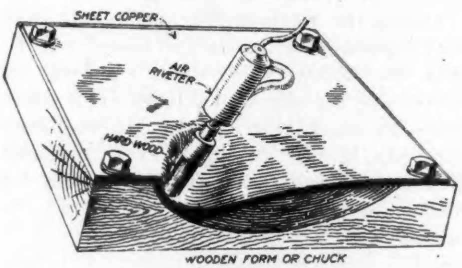
The process is of great value in this work as a locomotive, either steam or gasoline, may be so badly damaged by shell fire as to make replacement of the parts impossible, when it can, nevertheless, be repaired by welding. For example, one motor locomotive inspected had a cracked frame, a broken oil inlet pipe, and a broken cross member, involving the welding of steel, brass, and aluminum. This work was easily repaired, whereas otherwise it would have involved either the scrapping of the locomotive or the shippnig of the whole machine to a main repair shop located perhaps 100 miles to the rear. The repairs were actually made within 6 miles of the front.

On a front of about 60 miles there are three posts or repair yards for this class of work, serving about 250 locomotives in all. Each post has two sets of apparatus and three experienced men. About 100 cubic meters of oxygen are used monthly at each post.

These figures are given for a front which was extremely inactive at the time. A much larger use could be made of the process were equipment and men available. One set of welding apparatus and two men should be pro-

vided for from 40 to 50 locomotives and their cars or trucks.

Forts.—Oxy-acetylene welding has been found available in connection with repair work at forts, such as those surrounding Verdun. Broken cupolas, etc., can be repaired and débris cleared away by this process. At present one set of apparatus with two welders using six cylinders of oxygen and six cylinders of acetylene per month are employed to take care of all the forts around Verdun. A larger equipment than this would be desirable but can not be supplied at present.



FORMING SHEET-METAL WORK WITH AIR HAMMER

By Harvey Feldmeier

I recently had occasion to spin some large copper sheets in making dished heads for special tanks. This involved the making of spinning chucks and improvising a lathe consisting of a wooden frame, a spindle, spindle bearings and pulleys.

The actual spinning operation is simple, but when only a few pieces are to be made and no lathe or means of swinging a spinning chuck is available it is not often convenient. In such cases it is customary to raise the sheets by hammering them on a wooden block.

It occurred to me while watching a workman pound out a copper sheet in this way that an ordinary pneumatic riveter, if fitted with a simple socket so as to hold a wooden block, or mallet head, could be used for the purpose.

This was quickly rigged up and a test made by taking one of the spinning chucks, fastening the sheet over it, the sheet being held down by bolts at the edge, and by using the pneumatic riveter with the wooden head it was found that the metal could be easily forced into the chuck. This method may be old, but it was new to the writer, and seemed to open up a new way of embossing, or "raising," sheet metal, especially copper, without the necessity of having expensive tools.

After making up quite a number of tank heads from tinned copper in this way, we found that those which had been raised by the pneumatic-hammer process were much smoother and more perfect than those which had been spun, because there were no abrasions of the surface and no spinning marks. For raising sheet metal to regular shapes this would seem to offer a promising field.—*American Machinist.*

A PNEUMATIC "BOLTER-UP"

A mechanical bolter-up, which, according to *Over the Top,* promises to be a great aid to shipbuilders of America, has been invented by David Martyn, of the Vancouver steel yard of the G. M. Standifer Construction Corporation.

In shipbuilding thousands of temporary bolts are put in to draw up and pull the plates and bars together, before riveting. Those put in through the keel and shell at the bottom of the ship are tightened by workmen with uplifted arms. In that position it is not possible for a man to exert his full strength, because with one hand he holds the wrench on the nut, and with the other hand, he either pulls, or pushes the wrench.

When doing this he must use every care to prevent injury to his hands. Very often the wrench slips off the nut and his hand comes foul of one or more bolts and nuts already in place.

Mr. Martyn sought to make the work easier, to get more done, and eliminate the chance of injury. This he has accomplished in a simple and effective way. The workman does not lift the wrench and hold it in place. It cannot slip off. The energy is imparted at such a point that the workman's hands do not come near the other bolts and nuts.

The man may pull, or push, fearlessly and it was demonstrated that bolts could be pulled asunder every time without risk of injury to the person, while the machine showed no signs of yielding.

Martyn's machine will be made in three sizes, or rather in three lengths, for each will have sockets to fit ¾, ⅞ and 1-inch nuts.

Its construction is simple and very readily

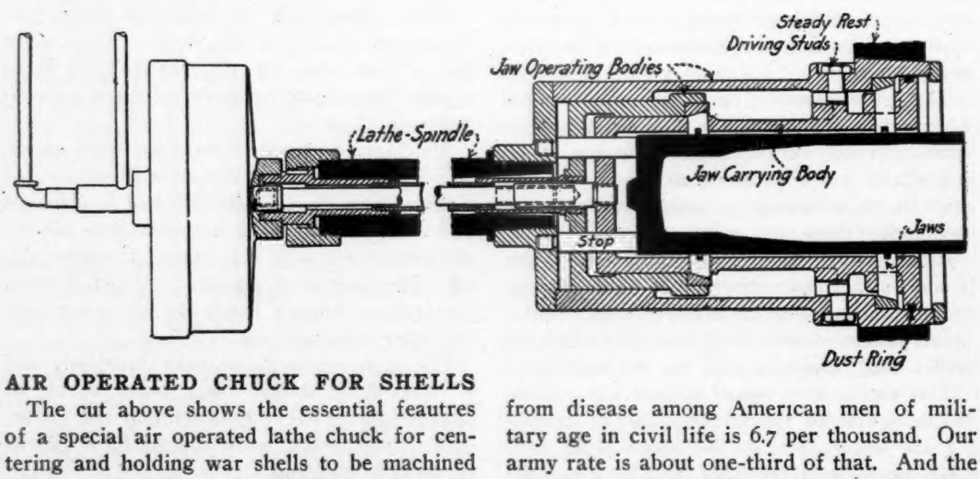
understood. First, there is a steel tube about 36 inches long, fitted with a cap at its bottom end; into the tube is fitted a suitable valve; to this is attached a compressed air hose.

Into the tube is placed a square piston rod, having a piston attached to its bottom end. At the top of this rod, sockets which fit the different size nuts may be placed.

Resting on the top of the tube is a piece of steel, hexagonal in shape, which has a square hole in it, to fit the square piston rod. A lever, or wrench, having a hexagonal hole, fits over the steel piece just described.

To use the machine, the workman attaches the compressed air, then opens the valve. The air forces up the piston rod and its top end, on which is the socket, is guided over the nut, onto the bolt to be tightened. The lever is turned round until the nut on the bolt is screwed up and the plates drawn together. To remove the machine the operator turns off the air.

The "bolter-up" also is an air jack, for the application tends to force the plates together, before tightening the nut, and at that time. By using it the plates, or bars, are brought firmly and close together, which insures good riveting and excellent workmanship. At the same time it is computed that by the use of this machine one man can do the work of five.



AIR OPERATED CHUCK FOR SHELLS

The cut above shows the essential feautres of a special air operated lathe chuck for centering and holding war shells to be machined on the inside. The lathe spindle is necessarily hollow and the air pressure is transmitted through it, the ordinary shop air pressure of 80 or 90 lb. being sufficient for the service. The chuck jaws are separate and operate independently for each end of the shell. When the air is released the jaws are entirely withdrawn, having the cylindrical interior of the chuck without any obstruction to interfere with the insertion or removal of the successive shells. A dust ring is provided for keeping the operative parts clean. A special chuck is of course required for each size of shell and the chucks are made from 3 in. dia. upward and corresponding lengths, by the Production Appliances Co., 14 South Jefferson street, Chicago.

HEALTH OF THE ARMY

During the Mexican War, the annual death rate from disease among our troops was 100 men out of every thousand. During our Civil War, the rate was as high as 60 out of every thousand. During our Spanish-American War, it was 25 out of every thousand. Now the Surgeon General's office reports that among our troops at home and abroad, the annual death rate from disease fluctuates from less than 2 per thousand to slightly more than 3 per thousand.

This is an incredible record. The best of all previous performances was in the Russian-Japanese war, when the annual death rate from disease among the Japanese troops was 20 per thousand. Our present rate is about one-tenth of that. The annual death rate from disease among American men of military age in civil life is 6.7 per thousand. Our army rate is about one-third of that. And the miracle has been achieved not by any one medical discovery or precaution, but by a campaign of administrative vigilance that has used every means to protect and promote and assure the health of millions of men.

NOTES

Government officials are now considering a plan to clean all material used in the manufacture of balloon fabric by a vacuum process. It is said that much of the material is rejected by inspectors because of dirt which has been worked into it in some manner.

The volume of natural gas from which the output of natural-gas gasoline in 1917 was recovered is estimated to have amounted to about 429,000,000,000 cu. ft., and the average recovery of gasoline per thousand cubic feet was about one-half gallon.

Indicative of how the logging industry of the Pacific northwest is undergoing an evolution especially with regard to the saving of man power is the fact that at the tenth annual session of the Pacific Logging Congress, at Portland, December 5 to 7, one of the important features will be a discussion of the use of compressed air in the woods. With the reality of the electric and gasoline donkey, operators want to go a step farther and utilize compressed air to advantage in sawing the fellod log in the woods.

The Norfolk and Western Railway recently had in its possession several carloads of corn that was heating on acount of excessive moisture. In order to preserve it, a hose and pipe was connected to air pressure tanks and compressed air at a pressure of from 70 lb. to 90 lb. was blown through the corn at various points in the car. Before the operation, the temperature was 107 deg.; during the hour that the operation was being conducted it was reduced to 80 deg., with the result that the corn was saved and delivery thereof effected.

A process for spraying metals upon any kind of surface, using metal melted in an electric arc and blown by means of gas jets upon the surface to be covered was described in a German publication. The metal to be sprayed forms one of the electrodes of the arc, and the gas jets are directed so as to strike the sides of the metal electrodes without impinging on the arc and blowing it out. If the arc is produced between two electrodes, one being metallic, and a stream of non-oxidizable gas is directed onto the electrode, portions of the electrode that are melted will be carried away in the form of a fine spray, and may be deposited on any surface on which they impinge, thus forming a metallic skin on it. Suitable control apparatus is provided to allow for the wear of the electrodes.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 6.

1,274,383. APPARATUS FOR UNLOADING COMPRESSORS. William H. Callan, Franklin, Pa.
1,274,396. DYEING-MACHINE. Howard M. Dudley, Philadelphia, Pa.
1,274,418. HUMIDIFIER FOR GASOLENE-ENGINES. Paul Hunt, Brookline, Mass.
1,274,478. AIR-GENERATOR. Frank I. Webb, McKeesport, Pa.
1,274,752. COMBINATION JOLT-RAMMING AND STRIPPING MACHINE. William C. Norcross, Terre Haute, Ind.
1,274,766. PNEUMATIC PIANO-PLAYER. Claus E. Peterson, Worcester, Mass.
1,274,810. VACUUM FUEL-FEEDING SYSTEM FOR GASOLENE-ENGINES. Harold C. Suckert, New York, N. Y.
1,274,955. FLUID MOTOR OR PUMP. August Sundh, Hastings-upon-Hudson, N. Y.
1,274,970. METHOD OF PRODUCING AND SEPARATING LIQUEFIED GAS. Linus Wolf, Chicago, Ill.
1,275,030. AIR-MOTOR. Olaf L. Howe, Missoula, Mont.
1,275,033. PNEUMATIC-TIRE VALVE. William C. Huntoon, Providence, R. I.
1,275,108. TRIPLE SANDING APPARATUS. Harry Vissering, Chicago, Ill.
A locomotive track sanding apparatus comprising in combination a sand trap, a rear sander and a plurality of front sanders on one side of a locomotive and fluid pressure means for discharging sand through either the rear sander or a plurality of front sanders.
1,275,171. TOOL-ACTUATING DEVICE. Thomas Officer and Morris P. Holmes, Claremont, N. H.
1,275,180. FLUID-PRESSURE GAGE. Evenio Ellis, Sheffield, England.

AUGUST 13

1,275,282. PRESSURE-GAGE FOR AIR-PUMPS. Raymond C. McGrath, Okemah, Okla.
1,275,306. PNEUMATIC SUPPORT FOR STRETCHERS AND BEDS. Morris W. Rosenshine, San Francisco, Cal.
1,275,316. PNEUMATIC CLUTCH. John Springer, Batavia, N. Y.
1,275,424. FEEDING GLASS. Halbert K. Hitchcock, Tarentum, Pa.
The method of feeding molten glass to shaping mechanism, which consists in drawing by suction a pre-determined quantity of the glass from a receptacle containing molten glass into a stationary inclosed displacement chamber, applying fluid pressure to the glass in the displacement chamber and thereby discharging it to the shaping mechanism and substantially emptying the displacement chamber, and then repeating the operation.
the operation.
1,275,440. AIR-PUMP. Harry O. Johnson, Calhan, Colo.
1,275,479. SAFETY-VALVE FOR AIR-

BRAKES. Michael H. Ryan, San Bernardino, Cal.

1,275,536. PROTECTIVE DEVICE FOR MOTOR-COMPRESSORS. Philip L. Crittenden, Edgewood, Pa.

1,275,547. APPARATUS FOR DRYING FRUIT. Thomas W. W. Forrest, Oakland, Cal.

1,275,592. AIR-LIFT BOOSTER. John Oliphant, Chicago, Ill.

1,275,747. AUTOMATIC VACUUM-CLEANER. George V. Rasmussen, New York, N. Y.

1,275,843. UNLOADING MECHANISM FOR COMPRESSORS. William H. Callan, Franklin, Pa.

AUGUST 20

1,276,016. AIR-CLEANER. Ashley C. Bennett, Minneapolis, Minn.

1,276,036. AIR-BRAKE FOR RAILROAD-TRAINS. Merrit A. Culling, Louisiana, Mo.

1,276,048-9. AIR-BRAKE FOR RAILROAD-TRAINS. Ernest D. Finley, Louisiana, Mo.

1,276,126. TIRE-PUMPING MECHANISM. Jacob L. Shroyer, Pittsfield, Mass.

1,276,163. CONTINUOUS-VACUUM DEHYDRATOR. Charles Biesel, El Paso, Tex.

1,276,184. MILKING MACHINERY. Norman John Daysh, Poughkeepsie, N. Y.

1,276,251-2. MACHINE FOR TAPPING BLAST-FURNACES. Benjamin J. Mullen, Leetonia, Ohio.

1,276,310. PNEUMATIC VEHICLE-SPRING. Henry P. Arndt, Amston, Conn.

1,276,373. METHOD OF AND APPARATUS FOR PUMPING FLUIDS. David W. Jones, Los Angeles, Cal.

1,276,478. FLAP-VALVE FOR TWO-CYLINDER COMPRESSORS. Reuben E. Bechtold, Fort Wayne, Ind.

1,276,495. SUCTION APPARATUS. John T. Crockett, Cartersville, Ky.

1,276,505. AIR-LIFT PUMP. Levi T. Edwards, Philadelphia, Pa.

1. In an air lift pump, an eduction pipe having the bounding wall of its bore formed of wood, said wall being uniformly tapered to provide a bore gradually increasing in cross-sectional area from the inlet end to the outlet end of said pipe.

1,276,506. AIR-LIFT PUMP. Levi T. Edwards, Penfield, Pa.

A foot piece for an air lift pump consisting of an annular body, a plurality of ring nozzles of different diameters, and means to support said nozzles in axial alinement with said body.

1,276,683. METHOD OF DRILLING GLASS. Harry Northwood, Wheeling, W. Va.

The method of drilling glass which consists in simultaneously subjecting opposite sides of a thickness of glass to the action of blasts of sand which meet and complete the cutting operation at a point intermediate the opposite faces of the thickness of glass.

1,276,699. PNEUMATIC-DESPATCH DELIVERY TERMINAL. Albert W. Pearsall, Lowell, Mass.

AUGUST 27

1,276,762. AUTOMATIC AIR-SUPPLY DEVICE AND COMBINATION-GOVERNOR THEREFOR. Edward G. Hodges, Marshalltown, Iowa.

1,276,803. MILKING-MACHINE. Carl H. Paarmann, Delmar, Iowa.

1,276,836. AIR-FEEDING DEVICE FOR FORGES, FURNACES, AND THE LIKE. Burton H. Tripp, Philadelphia, Pa., and Hugh V. Ramsay, Gloucester City, N. J.

1,276,871. VACUUM WATER-PURIFICATION SYSTEM. Oliver M. Campbell, Kansas City, Kans.

The process of purifying water which consists in distilling the water and removing the gaseous impurities from the vapor during condensation by subjecting said vapor to a continuous vacuum action at various points corresponding to the various successive stages of condensation of said vapor.

1,276,939. OIL-BURNER. William Mallory, Topeka, Kans.

In an apparatus for the purpose set forth, the combination of an oil reservoir, a compressed air reservoir, means for establishing a flow of air from the compressed air reservoir into the oil reservoir, a coil connected with the oil reservoir, means for controlling the flow of oil into the coil, means for admitting air to the upper end of the coil, a burner carried by and communicating with the lower end of the coil, means for admitting air to the lower end of the coil, and means for controlling the flow of fuel from the coil to the burner.

1,276,976. ATTACHMENT FOR AIR-BRAKES. Fred T. Shaw and Joseph G. Meador, Jr., Winchester, Miss.

1,276,987. APPARATUS FOR PRESERVING OBJECTS CONTAINING FLUID UNDER PRESSURE. Frank W. Stockton, Chicago, Ill.

1,276,989. AIR-GUN. Sven Svenson, La Crosse, Wis.

1,276,998. FLUID-PRESSURE BRAKE APPARATUS. Walter V. Turner, Wilkinsburg, Pa.

1,277,001. LOCOMOTIVE BRAKE DEVICE. Walter V. Turner, Wilkinsburg, Pa.

1,277,053. AIR-BRAKE MECHANISM. Samuel H. Elliott, Roanoke, Va.

1,277,068. WELDING-TORCH. John Harris, Cleveland, Ohio.

1,277,069. VALVE MECHANISM FOR BLOW-PIPES AND THE LIKE BURNERS. John Harris, Cleveland, Ohio.

1,277,080. RIVETING-HAMMER. Francis E. Johnson, Altoona, Pa.

1,277,143. AIR-BRAKE. James G. Smeltzer, Germantown, Pa.

1,277,151. CONDENSATE AND AIR REMOVING APPARATUS. Robert Suczek, Philadelphia, Pa.

1,277,261. AUTOMATIC AIR-BRAKE SYSTEM AND TRAIN-STOP. Frank A. Russ, Weatherly, Pa.

1,277,269. SPRAYING OR ATOMIZING SYSTEM. Herman Edward Sturcke, Brooklyn, N. Y.

Method of atomizing or spraying material such as paint by means of carbon dioxid in a pressure container, consisting in leading a stream of high pressure carbon dioxid gas from said container through a heated liquid bath, thereby heating said gas, reducing the pressure of said heated gas, leading said gas at reduced pressure through a heated liquid bath whereby to re-heat said gas, and subjecting the material to be sprayed to the action of said gas.

1,277,314. PRESSURE-GENERATOR. Frederick Homewood, Syracuse, N. Y.

1,277,320. OIL-BURNER. William A. Kinney and John F. Straitz, Philadelphia, Pa.

SEPTEMBER 3.

1,277,383. APPARATUS FOR PUMPING LIQUID AND GAS. Louis Bond Cherry, Kansas City, Mo.

1,277,393. APPARATUS FOR TREATING AIR AND THE LIKE. Alfred E. Davidson, Newark, N. J.

1,277,420. FLUID-COMPRESSOR. Samuel H. Human, Chicago, Ill.

1,277,529. PNEUMATIC ORGAN-ACTION. Basil G. Austin, Hartford, Conn.

1,277,586. AIR-MOISTENING DEVICE. James P. High, Fairview, Okla.

1,277,632. HUMIDIFIER. George Mizener, Decorah, Iowa.

1,277,684-5-6. VACUUM FUEL-FEED DEVICE. Louis Berg, Chicago, Ill.

1,277,752. AIR-COMPRESSOR. William Reavell, Ipswich, England.

1,277,779. COMBINATION GAS-ENGINE-DRIVEN AIR-COMPRESSOR. Frank M. Titus, Bradford, Pa.

1,277,831. ARMORED PNEUMATIC TIRE. Walter E. Baumberger, Sacramento, Cal.

1,277,854. TRAIN CONTROL. Howard Carlisle, Leesburg, N. J.